

Wm Charlton

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E S S A Y

ON

S H O O T I N G:

C O N T A I N I N G

The various Methods of forging, boring, and dressing Gun Barrels, practised in France, Spain, and England, and the different Proofs of Barrels employed in those Countries; with Remarks—An Investigation of the Causes of Recoil, and of Bursting; with Proposals for preventing or remedying them—An Inquiry into the Effects of the Length, Bore, and Charge, upon the Range, &c. of the Piece—Remarks on the Properties and Action of Gunpowder, and upon the Articles of Shot, Wadding, &c. &c.—Instructions for attaining the Art of Shooting—The Methods of training Pointers—And a short Description of the Game of this Country, as connected with the Amusement of Shooting.

The whole interspersed with summary Observations on the various Subjects of the Sport.

THE SECOND EDITION.

L O N D O N:

PRINTED FOR T. CADELL, IN THE STRAND.

M.DCC.XCI.



P R E F A C E

T O T H E

F I R S T E D I T I O N .

THE total want of a treatise in the English language such as the present, possessing either science or extent, is the principal inducement the author has, in offering to the public what he originally intended only for his own use and amusement. The idea of collecting and arranging the information he possessed upon this subject, was first suggested by the perusal of an ingenious publication that has lately appeared in France under the title of "La Chasse au Fusil."

Of this valuable work he has availed himself considerably, as will be seen by a comparison of it with the

present treatise ; but whilst he acknowledges his obligations to Mons. Magné de Marolles, the ingenious author, for much entertainment and instruction, he must at the same time observe, that if this Essay is found to possess any merit, a considerable portion of it is due to the personal experience of the writer : and as he has spared neither trouble nor expence in acquiring from the best workmen, every possible information that relates to the manufacture of gun-barrels, &c. he trusts that it will not be found unworthy the attention of persons who profess themselves attached to the amusement of shooting.

The sports of the field were the great delights of our ancestors ; nor could any amusements be so congenial to the dispositions and habits of a brave and warlike people, as those which served at once to invigorate the body and animate the mind.

By chase our long-liv'd fathers earn'd their food,
Toil strung their nerves and purified their blood.

DRYDEN.

The bow and arrow appear to have been among the earliest arms of chase and war in every country ; and however rude and artless they may now appear, the plains of Cressly and of Agincourt will for ever bear

testimony to their efficacy in the hands of English bowmen.

The restless and insatiable mind of man, however, could not remain satisfied with weapons of so simple a construction: the powers of invention were therefore tortured, in order to devise something more effectually destructive; but until Chemistry lent her aid to the vindictive spirit of the human race, the utmost efforts of mechanical ingenuity reached no farther than the cross bow, and there seemed to be wholly at a stand.

The discovery of gunpowder opened an entirely new field, and gave an almost boundless scope to the exercise of genius and of industry; with what success these have been employed in the improvement of fire-arms, few of our readers require to be informed.

It would still, however, be a subject of much curious research, and not without its use, to trace the progress of invention in the various arms of chase employed throughout Europe; to mark the gradual improvement of each, from the spear to the cross-bow, and from the clumsy match-lock to the elegant fowling-piece; and to determine the comparative excellence of different nations and different individuals in their manufacture and use.

In this enquiry the tribute of praise might perhaps be

viii PREFACE TO THE FIRST EDITION.

found due to our own country ; and whilst we challenged the world to rival our artists, we might be laudably vain of the respective qualities and superior skill of a Robin Hood, and a Colonel Thornton.

Such an investigation, however, besides that it would much exceed the bounds of an essay, belongs more properly to the antiquarian, than to the sportsman ; we shall therefore decline the attempt, and, for such information, refer the curious to the ingenious treatises of Mons. de Marolles and Captain Grose.

PREFACE

P R E F A C E

T O T H E

S E C O N D E D I T I O N .

TWO years have now elapsed since the first edition of this work made its appearance; an early sale of which, the importunities of friends, and the assurances of many sportsmen that a second edition was in demand, some time ago induced the author to think of reprinting the book. During this period he has taken occasion to improve the matter; for, in the course of investigation and experiment, many things had occurred to him which had been omitted, or mistakenly treated in the original publication, and many inaccuracies had been pointed out by others. He has, therefore, endea-

voured to remedy the defects which occurred or were suggested to him; and the additions made to the work, particularly those which relate to the properties and action of gunpowder, are such as seemed in some degree necessary to justify a second edition, and to make the whole more acceptable to sportsmen in general.

The assistance of gunsmiths eminent in their profession has frequently been solicited by the author, and has been as often proffered: promises however are generally found to be more readily made than performed; the ignorant wrap themselves up in the *profound secrets of the trade*, and those who have the most ability to lend their professional aid, seldom have leisure to give it, a circumstance the more to be lamented by the author, because, assisted by such, the present work might have been rendered more worthy the attention of sportsmen, by whom we trust no apology will be deemed necessary for again conducting them to the forge, the place from whence the chief instrument of their diversion springs.

Still, with all the additions that have been made, whether by personal industry, by what experience has furnished, or the knowledge of fellow sportsmen suggested, the author feels the work to be yet very imperfect. Experience, indeed, as well as experiment, has enabled
him

him to correct a few errors ; but the whole has otherwise served only to convince him that he knows less of the subject of his treatise, than he imagined he knew when he before offered it to the public.

Conscious of this, the author now requests a communication, through the bookseller, of any information which experience or professional knowledge may be able to furnish, of any hints for the improvement of the work, or of any censure of its inaccuracies. If therefore what is now offered to the public, shall be a second time so far approved as to encourage an attempt to render it more worthy of notice, the advantage which may be derived from any such communication, will be made use of for that purpose, and acknowledged by the author.

The ideas suggested in the following sheets, respecting the shot of fowling-pieces, contrary to the opinion received and established among gunsmiths (a set of men, who, by the way, have little or nothing to do with the *manufacture* of the most important part of the instrument), may be termed, not improperly, the *Metaphysic of the Art*.

The forger and the gunsmith together complete the instrument of the chase : but the sportsman who applies it to its proper use, and who studies its effects with the
spirit

spirit of curiosity and observation, without any kind of doubt, has the right to give his sentiments, and to propose the results of his experiments.

The author begs to be understood, that what he has said in the course of the work, respecting the fabrication of the various parts of fowling-pieces, is not intended for manufacturers ; he has only endeavoured to inform the sportsman in what manner the instrument to which he so eagerly attaches himself in its use, is made, and of which so many persons are completely ignorant.

And as to the utility of those parts of the present work which relate to the practice of the chase, the author has only to say, that he never pretended to write for finished sportsmen, or for those who make shooting their principal occupation and amusement ; the daily experience of such must suggest much more than he has dared to set down. Those practical observations are intended principally for such as are in the infancy of the art : but he ventures to flatter himself, that both the one and the other may find wherewithal to amuse and instruct. For the practical part of the subject may be considered, in some degree, as a matter of science ; and it may be supposed that those who excel in the art of shooting, may possess the knowledge of certain points, the whole of which being digested into a body of rules
and

and instructions, might form an elementary work, both useful and agreeable to sportsmen of every class.

The author, however, has to regret that he is not as yet competent to form such a work: but the frequent practice of a sport which is his chief amusement, may, one day or other, enable him to offer such to the public, along with those other additions which enquiry, experiment, or friendly communication may at a future period put it in his power to make to the work in general.

INTRODUCTION.

THE love of sporting seems to be inherent in the human race; the wants of the individual on the one hand, and his amusement on the other, prompt him to the chase. In its exercise, it calls forth the noblest exertions of the man, it engages all his faculties; and in pursuit of this mimic war, he is at once the hero and the monarch of the fields.

Although humanity, particularly in modern times, seems to shrink at the practice of the chase; yet in times the most enlightened, it has found its advocates. Poetry hath consecrated its eulogies. History hath ennobled her pages with the names of warriors formed under its laws. From it,
natural

natural history hath derived assistance. Sages have recorded its institutions. On the same lyre, the Genii of the woods celebrate the children of Mars and Latona; and conquerors, accustomed to dictate the rules of war, have not disdained to form the precepts of the chase.

Greece, the country of arts, of science, and of genius, in the brightest days of her glory, conferred on sportsmen the same homage that she paid to the *athletæ* in the immortal games; whilst the Muses of Athens sung in heavenly verse the mysteries of the chase.

The Romans, conquerors of Greece, kindled, at the altar of her genius, that taper which afterwards conducted them to the light of science. They sung in honour of the Gods who presided over the sports of the field, and taught their intrepid youth to declare war against the inhabitants of the woods. Horace, the poet of the Graces and the painter of Reason; the sublime Virgil, and the tender Ovid, have each of them soothed the labours of the hunter with
his

his mellifluous strains. The tranquil days of Augustus saw entire poems spring up to encourage its ardour; and whilst the arts themselves lost their splendour, the chase continued to receive from poetry her accustomed tributes, even under the reign of emperors, who, notwithstanding the obliquity of their natural dispositions, still appeared to interest themselves in the cultivation of the sciences, and the general interests of mankind.

Europe, after the irruption and conquests of the northern race, was for a long time enveloped with the clouds of ignorance. But the dawn of science and the light of reason had no sooner given day to Gothic barbarism, than the chase partook of their enlivening rays, and mankind again delivered themselves up to the fascinating ardour of its pursuit.

The exercise of the chase is, in truth, so noble in itself, that the greatest monarchs of the earth have authorized it by their example; in all ages it hath occupied the leisure of heroes themselves; with them,

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the pleasures of the chase succeeded the toils of war: it is the proper school of the foldier; it accustoms him to fatigue, it prepares him for assault, it sustains and seconds the courage of the man; in it is found the best relaxation from the cares and business of life; it is the only recreation without effeminacy, and the only one which bestows pleasure on its votary without a portion of ennui. To enjoy the converse of his own bosom, to steal from the importunities of others, to retire from the vapid amusements of the age, man has need of solitude; what solitude then is there more varied, or more animated, than that which the chase affords? what exercise more wholesome for the body? what repose more softening to the mind?

Jam undique silvæ et solitudo magna cogitationis incitamenta sunt.

Experieris non Dianam magis montibus quam Minervam inerrare.

C. PLIN. SEC.

In the preface to the former edition of this work, a hint was thrown out to antiquarians

quarians in general, that it might be a subject of curious research, to trace the progress of invention in the various weapons which were made use of in the chase, before the invention of fire-arms. We still think the subject worthy of enquiry; and the more so, when we consider the superficiality and frequent inaccuracy of those works which have hitherto treated of it. In these days, when invention seems to be exhausted, when new topics are no longer to be found, and when, in consequence, we see the first literary abilities employed in gleaning up the scraps of former ages, polishing them from the rust of antiquity, and carefully separating the finer particles from those more gross, we are persuaded, that, with a small part of that poring labour usually bestowed on such topics, a very curious and entertaining collection of eulogies, poems, instructions, rules and laws, relating to the various subjects of chase, in all ages, and in the countries of which we have sufficient account to extract materials, might be formed. To speak only of our own country; since we

know that the sports of the field were always congenial to the breast of a Briton, little doubt can be entertained, that his favourite and predominating amusement may have been sung in strains of poetry worthy redemption from the musty shelf of antiquity, and which, from such a research, might once more see the face of day, to the honour, not only of the ages in which they were written, but of the author who composed them, and to the fame and credit of him who shall be so fortunate as to restore them to the lost pages of literature. Will not the example of Dr. Percy excite the labours of some one?

To carry the consideration farther, such an enquiry might be extended to ascertain the precise period when the cross-bow succeeded to the feats of archery, and the epocha when that more complex instrument, in its turn, gave place to the superior effect of the fowling-piece—points not yet settled with sufficient accuracy.

In the comparative excellence of the two last instruments of chase, the fowling-piece, without

without doubt, possesses great advantages over the cross-bow; it is more easily managed, it is more expeditious, as well as more destructive in its effects; but still the cross-bow must be admitted to possess one very superior quality, that of killing without any considerable degree of noise, and thereby alarming the game—a circumstance much complained of by sportsmen in those times; for it appears by ancient authors, that, upon the introduction of the arquebuse in particular countries, the noise made by the discharge had so frightened and dispersed the game, particularly the *beasts* of chase, that they were become very scarce in those districts where the arquebuse was used.

Before the invention of fire-arms, the cross-bow was the principal instrument in the hands of sportsmen, and in much more general use than the bow and arrow, of which it is a modification, and over which it was found to possess the advantage of carrying, both to a greater distance, and with more certainty. Besides, the sportsman could adjust *bolts* of different dimensions to

it, according to the species of the game he was pursuing. We may thence imagine what accuracy of aim was required in the crossbow-man, since, to shoot with that instrument, was the same, at that time, as firing a single ball with a fowling-piece now: and as he never shot his *bolt* at a flying, and but very seldom at a running object, we are astonished to think what strength and nicety of vision must be required to discover the game on the ground, and what address and precaution he must possess, to supply the defects of his instrument, compared with those used at the present day.

The cross-bow, however, seems to have been in use after the invention of the arquebuse, and even when this last had been brought to some degree of perfection, and was rendered more manageable, compared with their first and original form. It appears that it was not until towards the end of the sixteenth century, that this instrument was wholly disused; at which time, the arquebuse was brought to such

8 perfection,

perfection, as to enable the sportsman to shoot flying: but the precise epocha of this circumstance would with difficulty be ascertained.

The origin of the invention of the arquebuse (or by whatever name it was first called) would also be a subject of curious investigation, together with the various progressive improvements made in its form and use; for, like the improvements of the present day, they had in their time their advocates and their enemies: and we smile to see a grave Spaniard, Nicolas Spadoni, arguing at great length, to prove that a fowling-piece, fired with a spring lock and a flint, was preferable, in its effects and its application to use, to the matchlock, which was still practised by many at that time, and who pretended in its favour, that the fire of the match was more quick and certain than the other. If there could have been any foundation for such an opinion, what locks must those have been, when compared with the various constructions of them at the present day! That Spadoni

was right, the practice of his own days, and the improvements of succeeding times, have sufficiently proved ; and we are not without hopes to see such an important and essential improvement introduced to the service of the artillery.

We can scarcely imagine that sportsmen aspired to shoot flying when the arquebuse was first applied to its use : it must have been with this invention as with all those others, the perfection of which is only developed by degrees, and according to a progression more or less slow, as circumstances will admit.

It is, therefore, easy to conceive, that mankind would, at the first, begin by shooting both the smaller and the larger game with a single ball ; they would afterwards proceed to load with two or three balls, in order to cover a greater surface ; they would then augment the number of these balls, decreasing their sizes in due proportion, until at length they would progressively arrive at small shot, with which they would at first be content to shoot the small game

set * ; then, by insensible degrees, they would be encouraged to shoot at objects both flying and running. Such seems to be the gradation which naturally presents itself to the human mind. A difference in these practices, however, would still take place in different countries, and amongst different individuals ; for at this time we find that in France there are persons, who, when they fire, place the stock of the piece against the centre of the breast ; that in England many good sportsmen shoot with both their eyes open at the instant of drawing the trigger ; and Pennant, in his Arctic Zoology, informs us, that the Prussian settlers in the isle of Spitsbergen, who are most excellent sportsmen, have a very peculiar method of presenting their piece ; for they do not raise it to the shoulder, but place the butt end between their arms and their side, fixing the eye steadily on the object toward which they direct the barrel.

* We here use the sportsman's term ; its grammatical propriety is very doubtful.

We

We have been thus copious in extending our remarks upon the hint formerly thrown out, in the no less serious hopes than wish, that they may excite the labours of some individual, of more leisure and ability than ourselves, more and more convinced, as we are, that the enquiries and researches here proposed will, in their results, have both their use and amusement. Earnestly, therefore, wishing that these hopes may not be disappointed, for the present, it only remains for us to take leave of the public, with thanks for their candour and kind reception of the former edition of this work, and humbly recommending to their protection the following sheets, as altered and enlarged.

CON-

C O N T E N T S.

C H A P. I.

F ORGING of barrels	- - - -	Page 1
----------------------------	---------	-----------

C H A P. II.

Boring and dressing of barrels	- - -	12
--------------------------------	-------	----

C H A P. III.

Improvements in the manufacture of barrels	-	29
--	---	----

C H A P. IV.

Proofs of barrels	- - - - -	52
-------------------	-----------	----

C H A P. V.

Causes of bursting	- - - - -	56
--------------------	-----------	----

C H A P. VI.

Of the recoil	- - - - -	63
---------------	-----------	----

C H A P.

CHAP. VII.

	Page
Range of barrels - - - - -	72

CHAP. VIII.

On the shot of fowling-pieces - - -	95
-------------------------------------	----

CHAP. IX.

Of the means which have been employed to improve the shot of fowling-pieces - -	104
--	-----

CHAP. X.

Of rifle barrels - - - - -	123
----------------------------	-----

CHAP. XI.

Of the stock, lock, &c. - - - - -	143
-----------------------------------	-----

CHAP. XII.

Remarks on the properties and action of gun- powder, and instructions for the choice of gunpowder, shot, wadding, &c. - -	151
§ 1. Powder - - - - -	152
§ 2. Shot - - - - -	193
§ 3. The proportions of powder and shot in the charge - - -	198
§ 4. Wadding - - - - -	203

CHAP. XIII.

Method of loading a fowling-piece - -	208
---------------------------------------	-----

CHAP.

CONTENTS.

xxix

CHAP. XIV.

	Page
Instructions for shooting well - - -	212

CHAP. XV.

General instructions on shooting - -	228
--------------------------------------	-----

CHAP. XVI.

Instructions for training pointers - -	237
--	-----

CHAP. XVII.

The game - - - - -	267
§ 1. The hare - - - -	268
§ 2. The rabbit - - - -	274
§ 3. The partridge - - -	280
§ 4. The pheasant - - - -	288
§ 5. The grouse, or muir-game - - -	292
§ 6. The woodcock - - - -	296
§ 7. The snipe - - - -	303
§ 8. The wild-duck - - - -	305
Addenda - - - - -	313

E R R A T U M.

Page 231, line 3, for *with* the wind, read, *against*
the wind.

AN
E S S A Y
ON
S H O O T I N G.

PART I.

AN
E S S A Y
ON
S H O O T I N G.

CHAP. I.

Forging of Barrels.

AS the manufacture of barrels varies considerably, we have thought it best to give a detail of the different methods employed; arranging them in such an order as will render their description as clear and concise as possible, and adding such observations

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vations as we have judged necessary for enabling the reader to decide upon their comparative merit.

To form a barrel in the manner generally practised for those denominated *common*, the workmen begin by heating and hammering out a bar of iron into the form of a flat ruler, thinner at the end intended for the muzzle, and thicker at that for the breech; the length, breadth, and thickness of the whole plate being regulated by the intended length, diameter, and weight of the barrel. This oblong plate of metal is then, by repeated heating and hammering, turned round a cylindrical rod of tempered iron, called a *mandril*, whose diameter is considerably less than the intended bore of the barrel. The edges of the plate are made to overlap each other about half an inch, and are welded together by heating the tube in lengths of two or three inches at a time, and hammering it with very brisk but moderate strokes, upon an anvil which has a number of semicircular furrows in it, adapted to the various sizes of barrels. The heat required for welding, is the bright white heat which immediately
1 precedes

precedes fusion, and at which the particles of the metal unite and blend so intimately with each other, that, when properly managed, not a trace is left of their former separation: this degree of heat is generally known by a number of brilliant sparks flying off from the iron whilst in the fire; although it requires much practice and experience to ascertain the degree of heat required for welding iron, which possesses various qualities, and is seldom alike. Every time the barrel is withdrawn from the forge, the workman strikes the end of it once or twice gently against the anvil, in a horizontal direction: this operation, which the English artists term *jumping*, and the French, *estoquer*, serves to consolidate the particles of the metal more perfectly, and to obliterate any appearance of a seam in the barrel. The *mandril* is then introduced into the bore or cavity; and the barrel being placed in one of the furrows or moulds of the anvil, is hammered very briskly by two persons besides the forger, who all the time keeps turning the barrel round in the mould, so that every point of the heated portion may come equal-

ly under the action of the hammers.—These heatings and hammerings are repeated until the whole of the barrel has undergone the same operation, and all its parts are rendered as perfectly continuous as if it had been bored out of a solid piece. The number of heats given to each portion of two or three inches, depends chiefly upon the quality of the iron, the purer kinds uniting and consolidating much more readily and perfectly than the ordinary ones; the very best, however, require at least three welding heats.

Whilst the barrel is in the fire, the French workmen have a practice of giving, from time to time, slight horizontal strokes with the hammer to the end they hold in their left hand, so as to communicate to the heated part a vibratory motion, that serves to disengage from the pores of the metal, and throw off, such particles as are in a state of fusion, and therefore not easily convertible into malleable iron: it also separates such scales and impurities as form upon, or adhere to the surface. This operation, however, can scarcely be necessary with the first view, where the iron employed is of a proper

per degree of purity; as by the repeated heatings and hammerings it has, in that case, already undergone, these heterogeneous and impure particles are in a great measure removed, and very little left behind except the pure fibres, as it were, of the metal.

The imperfections to which a barrel is liable in forging, are of three kinds, viz. the *chink*, the *crack*, and the *flaw*. The *chink* is a solution of continuity, running lengthwise of the barrel. The *crack* is a solution of continuity, more irregular in its form than the *chink*, and running in a transverse direction, or across the barrel. The *flaw* differs from both: it is a small plate or scale, which adheres to the barrel by a narrow base, from which it spreads out as the head of a nail does from its shank; and, when separated, leaves a pit or hollow in the metal.

With regard to the soundness of the barrel, the *chink* and *flaw* are of much greater importance than the *crack*, as the effort of the powder is exerted upon the *circumference*, and not upon the *length* of the barrel. In a sword, or bow, the very reverse of this takes place; for if a *crack*, though but of a

flight depth, occurs in either, it will break at that place, when bent but a very little; because the effort is made upon the fibres disposed longitudinally; whereas if the fault be a *chink*, or even a slight *flaw*, the sword or bow will not give way. The *flaw* is much more frequent than the *chink*; the latter scarcely ever occurring but in barrels forged as above, in which the fibres of the metal run longitudinally; and then only when the iron is of an inferior quality. When *external* and *superficial*, they are all defects in point of neatness only; but when situated within the barrel, they are of material disadvantage, by affording a lodgment to moisture and foulness that corrode the iron, and thus continually enlarge the excavation until the barrel bursts, or becomes dangerous to use.

The barrel, when forged, is either finished in the manner hereafter described, or made to undergo the operation of *twisting*, which is a process employed by the French workmen on those barrels that are intended to be of a superior quality and price to others; but which, as will be seen in the sequel, is
very

very different from that followed by the English workmen in the formation of *their* twisted barrels. This operation consists in heating the barrel in portions of a few inches at a time, to a high degree of red heat; when one end of it is screwed into a vice, and into the other is introduced a square piece of iron with a handle like an auger; and, by means of these, the fibres of the heated portion are twisted in a spiral direction, that is found to resist the effort of the powder much better than a longitudinal one. To render this operation as complete as possible, it is necessary to observe, that when once the several portions of the barrel have been twisted, the heats that are afterwards given in order to consolidate the fibres of the metal in their spiral direction, by means of the hammer, ought not to be very great; otherwise the grain of the metal will regain its former state, and the barrel be no better than it was before it underwent the twisting.

From the process it is evident, that to twist a barrel in this manner, throughout its whole length, it must be forged near a foot and half

longer than it is intended to be when finished, that a portion at each end may be kept cold, so as to give a sufficient purchase to the vice and twisting instrument during the operation: these portions are afterwards to be cut off before the barrel is bored. Or, to save the time and labour this would necessarily take up, two pieces of an old barrel may be welded to the muzzle and breech of that which is to be twisted, and cut off after the operation is finished: these pieces may also be made stronger than usual, the better to sustain the force of the vice and twisting instrument; and, in order to give the latter a better hold, the muzzle piece may have its cavity made of a square form. From not following one or other of these methods, the greater number of the French barrels *said* to be *twisted*, are only so in part, there being at least six inches at the muzzle, and seven or eight at the breech, which are not affected by the operation. The English workmen with whom we have conversed upon this subject, are all of opinion, and seemingly with reason, that this process of twisting,

ing, as performed by the French workmen, is really injurious to the barrel, by straining the fibres of the metal.

To persons unacquainted with the loss which iron suffers in forging, it will be a matter of surprise that twelve pounds of iron are required to produce a barrel, which, when finished, shall not weigh more than two pounds, or two pounds and a half. But although a considerable waste is unavoidable, yet the quantity of it depends very much upon the quality of the iron, upon that of the coal, and upon the knowledge and dexterity of the workman. By much the greater part is consumed in the fire; and the waste here may arise either from the iron being impure, from its being kept too long in the fire, or from the coal imparting sulphur to it, and making it run*: a considerable por-

* In Spain they cannot work but with charcoal of wood; in France they employ pit-coal charred, or *coaks*; in England they use pit-coal without being charred, but are very careful to have it of the purest kind, some sorts containing a portion of sulphur and arsenic which render the metal altogether unmalleable, or, in the language of the workmen, *poison* the iron.

tion is also driven off in the form of scales by the hammer, especially when the iron is hammered at a low red heat : the remainder is taken away in the after operations of boring and filing the barrel. Musquet barrels, and those for ordinary fowling pieces, are all forged of Swedish iron ; that which comes from Russia being too coarse and untractable to be wrought into barrels of any kind.

A circumstance of considerable importance to the excellence of a barrel, is, the forging it as near as can be to the weight it is intended to be of when finished, so that very little be taken away in the boring and filing ; for as the outer surface, by having undergone the action of the hammer more immediately than any other part, is rendered the most compact and pure, we should be careful to remove as little of it as possible : the same thing holds, though in a less degree, with regard to that portion of the inside of the barrel which is to be cut out by the boring instrument.

Pistol barrels are forged in one piece, and
are

are cut afunder at the muzzles after they have been bored ; by which there is not only a saving of iron and of labour, but a certainty of the caliber being perfectly the same in both.

C H A P. II.

Boring and Dressing of Barrels.

THE next operation consists in giving to the barrel its proper caliber: this is termed *boring*, and is performed by means of the following machine.

Two beams of oak, each six or seven feet long, and about six inches square, are placed horizontally and parallel to each other, by having each of their extremities mortised upon an upright piece, which is of equal strength, about three feet high, and firmly fixed. Between the horizontal pieces there intervenes a space of three or four inches, in which a piece of wood is made to slide, by having at either end a tenon that is let into a groove which runs on the inside of each beam its whole length. Through this sliding piece there is driven, or rather screwed, in a perpendicular direction, a strong
pin

pin or bolt of iron, having at its upper end a round hole or eye large enough to admit the breech end of the barrel, which is secured in it by means of a piece of iron that serves as a wedge, and a vertical screw that passes through the upper part of the eye, or hole. To a staple in one side of the sliding piece, there is fastened a chain, which runs between the two horizontal beams, and passing over a pully at one end of the machine, has a weight which may be hooked on to it at pleasure. Immediately above this pully, and between the ends of the beams, there is fixed an upright piece of timber, whose upper end is perforated by the axis of an iron crank that is furnished with a square socket; the other axis being supported by the wall, or by a strong post, and loaded with a heavy wheel of cast iron, to give it force: the axes of this crank are in a line with the eye of the bolt already mentioned. The borer being fixed into the socket of the crank, has its other end, which is previously well oiled, introduced into the barrel, whose breech part is made fast in the eye of the bolt; the chain is then carried over the pully,
and

and the weight hooked on ; when, the crank being turned by the hand, the barrel advances as the *borer* cuts its way, until the instrument has passed through its whole length.

The boring *bit* is a rod of iron, somewhat longer than the barrel ; one end being made to fit the socket of the crank, and the other being furnished with a cylindrical plug of tempered steel, about an inch and a half in length, and having its surface cut in the manner of a perpetual screw, the threads (which are five or six in number) being flat, about a quarter of an inch in breadth, and running with very little obliquity. The furrows are of the same breadth as the threads, and of a sufficient depth to let the metal cut out by the latter, pass through them easily, so as to keep the instrument free. This form gives the bit a very strong hold of the metal; and the threads being sharp at the edges, scoop out and remove every roughness and inequality from the inside of the barrel, and render the cavity smooth and equal throughout. A number of bits, each a little larger than the preceding one, are afterwards successively

cessively passed through the barrel in the same way, until it has acquired the intended caliber.

The borer heats the barrel very much, especially the first time it is passed through ; and generally warps it more or less. To prevent this in some measure, the barrel is covered with a cloth, which, by being kept constantly wetted, hinders the barrel from becoming too warm, and also preserves the temper of the boring bit. The borer is likewise withdrawn from time to time, to clear away the shavings of the metal, to oil the *bit* afresh, and to repair any damage it may have sustained during the operation. The barrel is carefully examined every time a fresh *bit* has been passed through, to see if it be in the least warped by the boring ; and also to discover if there are any spots, called by the workmen *blacks*, on its inside. If it be cast, or warped, it is carried to the anvil, where, by a few slight strokes of the hammer upon the convex parts, it is brought perfectly straight again ; this is termed *setting up* the barrel. If, when the barrel is nearly arrived at the intended caliber, any dark spots are perceived
upon

upon its inside by looking through it when held up to the light, the part is marked upon the outside ; and, by striking it gently with the hammer, is driven in so as to be completely removed by repassing the boring instrument.

To ascertain the equality of the bore, a cylindrical plug of tempered steel about an inch long, highly polished, and fitting the bore exactly, is screwed upon the end of an iron rod, and introduced into the cavity of the barrel, where it is moved backwards and forwards ; and the places being marked where it passes with any difficulty, the boring bit is repeatedly passed until the plug moves through every part with equal ease.

The equality of the bore is so essential to the excellence of a piece, that the greatest accuracy in every other particular will not compensate for the want of it. Any person who wishes to know the merit of his piece in this respect, may do it with tolerable accuracy, by means of a plug of lead, cast on a rod of iron or wood ; or even by a musquet ball filed so as to fit the bore exactly, and pushed through the barrel by the ram-rod,

rod, care being taken not to use an iron ram-rod, or much force, lest the ball be flattened, and an artificial difficulty created.

It now remains to smooth the inside of the barrel, and remove the marks left by the boring instrument. This operation is termed *fine boring*. The instrument with which it is performed, resembles in its general form the boring bits already described; the cutting portion of this, however, is a square broach, ten or twelve inches in length, highly polished, and very sharp, whereby it cuts the metal very smoothly. As it is found to cut more smoothly and equally when only two of its edges are allowed to work, the other two are covered by slips of paper, well oiled, being laid along one of its sides; one or more additional slips being put on every time the instrument is passed through the barrel. This instrument is repeatedly passed through the barrel, from breech to muzzle, and from muzzle to breech, until the inside presents to the eye a perfectly equal and polished surface: the barrel is also examined at each time, and, if necessary, *set up* in the manner already described. It is very essen-

tial to the perfection of the *fine boring*, that the instrument employed be forged perfectly true, and that it has not been cast or warped in the tempering.

The barrel may now be considered as quite finished with regard to its inside ; at least it has nothing more done to it by the *maker*. The *gunsmiths*, however, generally make it undergo a farther operation of polishing, the good effects of which are very doubtful, as will be evident from the manner in which it is performed. Upon a rod of iron somewhat longer than the barrel, they cast a cylinder of lead five or six inches long, which they file so as to fit the bore exactly : this is then covered with very fine emery and oil ; and being introduced into the barrel, is wrought backwards and forwards through its whole length, until the cavity has acquired a high degree of polish. Now it is scarcely possible for this instrument to be wrought by the hand, in such a steady and equal manner as not to press more upon some parts of the barrel than upon others. Besides, the exquisite polish which is produced by this operation, lasts but for a short time ;

time; and the polish it received from the hands of the maker seems fully sufficient for every useful purpose.

The barrel is now in a condition to receive its proper form and proportions externally, by means of the file. To do this with accuracy, four flat sides or faces are first formed; then eight, then sixteen; and so on, until it is made quite round; except the reinforced part, which, in most of the modern work, is left with eight sides*. In this, however, different gunsmiths exercise their own fancy and taste, both with respect to the number of sides and the length of the reinforced part.

It is absolutely necessary to the soundness of a barrel, that it should be of an equal thickness on every side; or, in the language of the workmen, *a barrel ought to be perfectly upright*. In order to arrive as nearly as pos-

* This octagonal form of the reinforced part, is certainly more elegant than the round one formerly in use. But it adds to the weight of the barrel, without increasing its strength; for the effort of the powder will be always sustained by the thinnest part of the circumference, without any regard to those places that are thicker than the rest.

sible to this perfect equality, the gunsmiths employ an instrument which they call a *compass*. It consists of an iron rod bent so as to form two parallel branches about an inch distant from each other. One of these branches is introduced into the barrel, and kept closely applied to the side by means of one or more springs with which it is furnished: the other branch descends parallel to this, on the outside, and has several screws passing through it with their points directed to the barrel. By screwing these until their points touch the surface of the barrel, and then turning the instrument round within the bore, it is seen where the metal is too thick, and how much it must be reduced in order to render every part of the barrel perfectly equal throughout its circumference. This instrument may be made sufficiently long to reach the whole length of the barrel; but it will be more convenient, as well as more exact, to have it little more than half the length; and to introduce it first at one end, and afterwards at the other, of the barrel.

The compass, however, is an instrument so extremely imperfect in its own nature,
that

that it requires very delicate management, even when of the best construction, to shew the equality of the barrel to any degree of accuracy.—The gunsmiths have all of them compasses of different constructions, each of whom fails not to praise his own as the best. But that invented by *Manton* is the best of the kind which we have seen.

Some persons, instead of dressing the outside by means of the file and compass, do it, at least the round part, by turning in a lathe. This method is without doubt more expeditious than that just described; but it is by no means certain that it is equally safe, or even equally exact. It is impossible to prevent a spindle that is the length of a gun barrel, from springing considerably under the tool employed to reduce or smooth the barrel in turning; and, accordingly, it is found that barrels are often more warped in the turning, than in any of the borings they have undergone; and that, from their greater thinness at this time, they cannot be *set up* as before without danger of ruining them entirely.

When the barrel is completely dressed and

smoothed on the outside, the French workmen proceed to folder on the loops and aim, before they breech the barrel; for, as they use *hard* folder, the degree of heat necessary in the operation, produces a roughness on the inside of the barrel opposite to the places where they are fixed; and this is sometimes so considerable as to require the *fine boring* instrument to be again passed through the barrel, which could not be done after the screw is formed for the breech, without injuring the threads. The English workmen, however, fasten on the loops, &c. with *soft* folder, which is found quite sufficient for the purpose; and as the heat required for this does not affect the inside of the barrel, they have the choice of doing it either before or after the breeching, as is most convenient to themselves.

To form the screw in the breech end of the barrel, the first tool employed is a plug of tempered steel, somewhat conical, and having upon its surface the threads of a male screw. This tool, which is termed a *screw tap*, being introduced into the barrel, is turned from left to right, and back again, until

until it has marked out the three or four first threads of the screw : another less conical *tap* is then introduced ; and when this has carried on the impression of the screw as far as it is intended to go, a third *tap* is employed, which is nearly cylindrical, and scarcely differs from the plug of the breech which is intended to fill the screw thus formed in the barrel.

The breech *plug* has its screw formed by means of a *screw plate*, made of tempered steel, and has several *female* screws corresponding with the *taps* employed to form that in the barrel. A plug of seven or eight threads is sufficiently long ; and the threads ought to be neat and sharp, so as to fill completely the turns made in the barrel by the *tap*. The breech plug is afterwards *case-hardened*, or has its surface converted into steel, by being covered over with shavings of horn, or parings of horse hoof, and kept red-hot in the fire for some time, after which it is plunged into water.

The last operation is that of colouring the barrel, previous to which it is polished with fine emery and oil, until it presents to the

eye, throughout its whole length, and in whatever direction we observe it, a perfectly smooth, equal, and splendid surface. Formerly, barrels were coloured by exposing them to a degree of heat which produced an elegant blue tinge; but as this effect arises from a degree of calcination taking place upon the surface of the metal, the *inside* of the barrel always suffered by undergoing the same change. This, therefore, added to the painful sensation excited in the eye by looking along a barrel so coloured, has caused the practice of *blueing* to be disused for some time past. Instead of it, barrels are now *browned*, as it is termed. To do this, the barrel is rubbed over with *aqua fortis* or *spirit of salt*, diluted with water, and laid by until a complete coat of rust is formed upon it; a little oil is then applied; and the surface being rubbed dry, is polished by means of a hard brush, and bees wax.

When the barrels intended for a double-barrelled piece are dressed to their proper thickness, which is generally less than for single barrels, each of them is filed flat on the side where it is to join the other, so that they

they may fit closely together. Two corresponding notches are then made at the muzzle and breech of each barrel; and into these are fitted two small pieces of iron, to hold them more strongly together. The barrels being united by tinning the parts where they touch, the *ribs* are fitted in, and made fast by the same means. These ribs are the triangular pieces of iron which are placed between the barrels, running on the upper and under sides their whole length, and serving to hold them more firmly together. The under rib is a late improvement, and is found more effectually to prevent the barrels from warping. When the barrels are thus joined, they are polished and coloured in the manner already described.

Great care should be taken that the barrels intended to be joined in this way, be perfectly *upright*, and that both be of the same thickness and strength; for, if but a very trifling inequality in this respect takes place, the weaker barrel will yield to the stronger: the warping from this cause has been sometimes so considerable, as to render one of the barrels altogether useless. To
bring

bring every part of the circumference of each barrel as nearly as possible to an equal strength, so that the force of the explosion may not strain one part more than another ; that side where the barrels touch each other, must be so reduced, that the partition between the two calibers be no thicker than either barrel was at the same place before it was filed to join in this manner.

Formerly, the double-barrelled pieces were made with one barrel lying over the other, each barrel having a separate pan, hammer, and hammer-spring ; but there was only one cock for both. The barrels were therefore made to turn round at the place where their breeches joined with the stock ; so that, as soon as one was fired off, the other could be brought into its place, by pressing with the right hand a spring moved by the guard, whilst with the left the barrels were turned upon their common axis : as soon as the charged barrel was thus brought into its proper situation, the spring descended into a notch, and kept it firm. From the description, it is evident, that all the work
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giving motion to the cock, must be confined to the part behind that at which the barrels turn round, and, from its being thus crowded, must of course be more difficult to construct; and the time taken up in thus turning the barrel round, almost renders the second barrel useless.

In the same way, three, and even four barrels, have been mounted upon one stock; but as these pieces are intolerably heavy, and do not, any more than those just described, possess any real advantage over the double-barrelled pieces that do not turn round, we shall forbear entering into any further description of them.

But a better mode was afterwards invented for double-barrelled pieces of this description; the barrels did not turn round upon an axis, they were fixed one over the other; and each had a separate lock and trigger, that for the under barrel being consequently placed lower than the other. Still, although pieces of this construction possess a great advantage over those that turn round, in the quickness of their firing; yet they
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are subject to one inconvenience from which the others are exempt, and which takes place in the under barrel ; for that being fired under the same line of aim with the upper one, must necessarily shoot low.

CHAP.

CHAP. III.

Improvements in the Manufacture of Barrels.

HAVING described, we hope with sufficient clearness, the several processes gone through in the manufacture of ordinary barrels, and the methods of finishing, which are equally adapted to every sort; we now proceed to give an account of a great variety of *real*, as well as *fancied* improvements, that have been suggested and practised at different times; beginning with the *twisted* barrels, as made by the English workmen.

These barrels are deservedly celebrated for their superior elegance and strength, as well as for the accuracy with which they throw either ball or shot. The iron employed in them is formed of *stubs*, which are old
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horse-shoe nails, procured from country farriers, and from poor people who gain a subsistence by picking them up on the great roads leading to the metropolis. These are originally formed from the softest and toughest iron that can be had; and this is still farther purified by the numerous heatings and hammerings it has undergone in being reduced from a bar into the size and form of nails. They cost about ten shillings the hundred weight, and twenty-eight pounds are required to make a single barrel of the ordinary size. A hoop of iron about an inch broad, and six or seven inches diameter, is placed perpendicularly; and the *stubs*, previously freed from dirt by washing, are neatly piled in it, with their heads outermost on each side, until the hoop is quite filled and wedged tight with them; the whole resembling a rough, circular, cake of iron. This is put into the fire until it has acquired a white heat; when it is hammered either by the strength of the arm, or by the force of machinery, until it coalesces, and becomes one solid mass of iron: the hoop is then removed, and the heatings and hammerings repeated

repeated until the iron, by being thus wrought and kneaded, is freed from every impurity, and rendered very tough, and close in the grain; the workman then proceeds to draw it out into pieces of about twenty-four inches in length, half an inch or more in breadth, and half an inch in thickness.

These pieces, however, are not all of the same *thickness*; some being more and others less than what we have mentioned, according to the proposed thickness of the barrel, and that part of it which the piece is intended to form. One of these pieces being heated red-hot for five or six inches, is turned like a cork-screw, without any other tools than the anvil and hammer. The remaining portions are successively treated in the same manner; until the whole piece is turned into a spiral, forming a tube whose diameter corresponds with that of the intended barrel. Four of these are generally sufficient to form a barrel of the ordinary length, which is from 32 to 38 inches; and the two which form the breech, or reinforced part, are considerably thicker than those which constitute the fore part, or muzzle of

the barrel. The workman first welds one of these tubes to a part of an old barrel, which serves as a handle. He then proceeds to unite the turns of the spiral to each other, by heating the tube two or three inches at a time, to a bright white heat, and striking the end of it several times against the anvil, in a horizontal direction, and with considerable force: this is termed *jumping* the barrel; and the heats given for the purpose, are called *jumping heats*. A mandril is then introduced into the cavity; and the heated portion is hammered lightly, to flatten the ridges or burrs raised by the jumping at the place where the spirals are joined. As soon as one piece is *jumped* its whole length, another is welded to it, and treated in the same manner, until the four pieces are united; when the part of the old barrel, being no longer necessary, is cut off. The welding the turns of the spiral is performed exactly in the same manner as described (p. 3 and 4) for plain barrels, and is repeated *three* times. The barrel is afterwards finished in the same way as a common one. Stub iron is also wrought into plain barrels, which,

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as they require a great deal less labour, are only half the price of the *twisted* ones.

The *Canons à ruban*, or *ribbon barrels*, of the French, very much resemble the English twisted barrels. The process pursued in their formation is considerably more operose than that just described, but seems to be far from possessing any advantage over it, as will be evident from a description of the former, which we here subjoin. A plate of iron, about the twelfth part of an inch in thickness, is turned round a mandril, and welded its whole length, in the same manner as a plain barrel. Upon this small and light barrel, which is called the *lining*, a stripe or plate of iron, about an inch in breadth, and beveled off at the edges, is rolled in a spiral direction, by means of successive heats: this spiral is termed the *ribbon*, and its thickness must correspond with the part of the barrel it is to constitute. As a ribbon of sufficient length to cover the lining from one end to the other would be very difficult to manage, it is formed in several pieces; and as soon as

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one piece is nearly rolled on, another is welded to the end of it, and the operation continued until the whole of the lining is covered. The edges are bevelled so much, that one edge overlaps the other about a quarter of an inch. When the *ribbon* is all rolled on, the barrel is heated by two or three inches at a time, and the turns of the spiral united to each other and to the lining, by being welded in the same manner as a twisted or a plain barrel *, but requiring more care and accuracy in the operation. It is afterwards bored so that almost the whole of the lining is cut out, and scarcely any thing left except the ribbon with which it was covered.

The acknowledged superiority of twisted and ribbon barrels over plain ones, has induced some persons to counterfeit them, by colouring plain barrels so as to shew a spiral line running from one end to the other. This is done by winding a thread

* From the construction of *ribbon barrels*, it is evident that the operation of *jumping* is not admissible in them.

or string in a spiral direction round a plain barrel, and then wetting the string with the diluted aqua fortis, or spirit of salt, so that a coat of rust may be formed where the string touches: when the acid is applied a second time over the whole barrel, the part over which the string was applied, by being more rusted than the rest, shews a dark line winding round the barrel, and renders it, when finished, scarcely distinguishable from a twisted or ribbon barrel. Other barrels are, by the same means, clouded in an irregular manner, so as to resemble those formed of *sub* iron. To prove whether or not a barrel is really what it appears to be, we need only fix upon any part on the under side, that is covered by the stock, and having cleared it, if necessary, with a fine file, apply a feather dipped in aqua fortis, which in a little time will render the fibres of the metal distinctly visible, in whatever direction they run. In examining the *French twisted* barrels, however, we must not make the trial near either the breech or the muzzle, as we have already observed, that these barrels are

seldom twisted throughout their whole length.

An ingenious workman called Barrois, formerly established at Paris, and but lately dead, having considered the estimation in which *ribbon* barrels were held, invented a new sort, which he called *wired* barrels. His method was this. Upon a thin barrel, forged, filed, and dressed as usual, he rolled, in a spiral direction, and as closely as possible, a tempered iron wire, about the thickness of a crow quill; the first layer covering only the fortified or reinforced part. The turns of the wire were foldered to each other, and to the barrel, with a particular composition which he kept a secret. He then filed the wired part so as to render it smooth and bright, but not so much as to weaken it; and applied a second layer of wire, which covered the first, and extended two-thirds of the length of the barrel: the second layer being foldered and brightened like the first, he added a third that covered the two first, and reached quite to the muzzle.

This process of the Sieur Barrois is
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ingenious; and *Monf. de Marolles* says, that one of these barrels which was forced in the proof, warped and swelled out without bursting. But, however plausible the contrivance may be, it is certain that these barrels are liable to imperfections from which the greatest address and care of the workmen cannot entirely free them. Wire is drawn from the bar without heat, and it is not improved in the smallest degree by the operation; these barrels have, therefore, no claim to preference on account of the quality of the metal, which is really no better than that of which the ordinary barrels are made.

No metal has yet been found equal to iron, for making gun barrels; and as the space occupied by the folder in the barrels of the *Sieur Barrois* is nearly equal to that taken up by the wire, the strength of the barrel is considerably less than if the whole had been formed of iron only. Independent of the defects that may occur in the wire itself, there will always be little cavities between its turns, which will not

be completely filled by the folder. Besides, as this *wiring* was performed by the Sieur Barrois upon a barrel that had been previously bored and dressed within, the repeated considerable heats it was necessarily exposed to in the foldering, if they did not warp it, at least rendered it so rough on the inside, that it required to be fine-bored afterwards. The only superiority, therefore, which they could be said to possess, was, their beautiful appearance when finished; and this was greatly overbalanced by the circumstances mentioned, and by the extravagance of their price, a single barrel amounting to 120 French livres, or 5*l*. sterling, and a double barrel to twice that sum. Their sale, however, by no means answered his expectations, and since his death no other person has thought of making them. With regard to the treble proof to which the Sieur Barrois pledged himself in his Prospectus, published in 1771, to submit his barrels, it is never refused by the gunsmiths of any country, provided the barrels be of a suitable thickness; and
those

those of Barrois were even thicker than ordinary.

The Spanish barrels have always been held in great esteem, as well on account of the quality of the iron, which is generally considered as the best in Europe, as because they possess the reputation of being forged and bored more perfectly than any others. It should be observed, however, that, of the Spanish barrels, those only that are made in the capital are accounted truly valuable; in consequence of which a great many have been made at other places, especially in Catalonia and Biscay, with the names and marks of the Madrid gunsmiths: they are also counterfeited at Liège, Prague, Munich, &c. and a person must be a very good judge not to be deceived by these spurious barrels.

Notwithstanding there have always been excellent gunsmiths at Madrid, yet the barrels which bear the highest price, and are the most sought after by the curious in this way, are those made by artists who have been dead for many years; though

perhaps this preference has no better foundation than the common prejudice in favour of things that are the productions of remote ages or distant countries: *Major e longinquo reverentia*. Such are the barrels of *Nicolas Biz*, who was famous at Madrid in the beginning of this century, and died in 1724: those he made in the former part of his life are the most esteemed. The barrels of *Juan Belen*, and *Juan Fernandez*, cotemporaries of *Nicolas Biz*, are not less prized; and in France all of them sell for 1000 livres, or 43l. 15s. sterling. Those of *Diego Esquibel*, *Alonzo Martinez*, *Gabriel Agora*, *Agostin Ortiz*, *Matbias Vaëra*, *Luis Santos*, *Juan Santos*, *Francisco Garcia*, *Francisco Targarone*, *Josèph Cano*, and *N. Zelaya*, all of them celebrated workmen, who succeeded those already mentioned, in the order of their names, are also in great request.

Of the artists now or lately living at Madrid, the most celebrated are, *Francisco Lopes*, *Salvador Cénarro*, and *Miguel Zeguarra*, gunsmiths to the king: *Isidoro Soler*,
and

and *Juan de Soto*, have also great reputation. The barrels of those living workmen sell for 300 French livres, or somewhat more than 13l. sterling, which is the price paid for those made for the king and royal family. They are proved with a treble charge of the best powder, and a quadruple one of swan or deer shot. At Madrid, and throughout all Spain, the manufacture of barrels is not, as in this and most other countries, a separate branch of the gun-making business; but the same workman makes and finishes every part of the piece.

After the barrels of Madrid, those of *Bustindui* and *St. Olabe* at Placentia in Biscay; and of *Jean* and *Clement Pedroestevea*, *Eudal Pous*, and *Martin Maréchal*, at Barcelona, are the most esteemed; these usually sell in France for 80 French livres, or 3l. 10s. sterling.

Almost all the barrels made at Madrid are composed of the old shoes of horses and mules, collected for the purpose. They are all welded longitudinally; but instead
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of being forged in one plate or piece, as in other countries, they are made, like the English twisted barrels, in five or six detached portions, which are afterwards welded one to the end of another, two of them forming the breech, or reinforced part of the barrel. We may form some idea of the very great purity to which the iron is brought in the course of the operation, when we are told, that to make a barrel, which, rough from the forge, weighs only six or seven pounds, they employ a mass of mule-shoe iron weighing from forty to forty-five pounds; so that from thirty-four to thirty-eight pounds are lost in the heatings and hammerings it is made to undergo before it is forged into a barrel.

The advantages which the Spanish workmen allege to result from this method of forging the barrel in several pieces, are,

First,—That the iron, by being forged in smaller portions, is the better wrought and purified.

Secondly,—That should a defect be discovered in any one of the pieces after being

ing turned into a cylinder and welded, they can reject that one, and substitute another.

Thirdly,—That by proportioning the thickness of each piece to the part of the barrel it is intended to occupy, very little is left for the file to do.

The *first* of these advantages is very trifling; for the division is not, as in the case of *stubs*, so minute as to expose to the action of the fire and the force of the hammer, a surface considerably greater than if the barrel had been forged in a single piece. The *second* is not confined to barrels forged in separate pieces; for if a defect be observed at any part of a barrel that is forged in a single piece, the part can be cut out, and the ends of the sound pieces joined, or a new piece welded between them. With regard to the *third*, it may, perhaps, be useful to forge the reinforced part in *one* piece, and the rest of the barrel in another; but it certainly cannot be necessary for the same reason to forge it in five or six pieces.

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This, however, is not the only thing in which the Spanish workmen differ from those of other countries. Instead of making the plate overlap a *little* where it is joined, they give it another complete turn, so that every Spanish barrel may be said to be double throughout. The different portions are also forged, so that the grain of the iron, instead of being longitudinal, is disposed circularly, and follows the round of the barrel in such a manner as to give the effect of a *ribbon* or *twisted* barrel. They do not regulate the thickness of the barrel by means of the *compass*, but in its room employ round rulers to conduct the file; and finish the outside by turning in a lathe: perhaps it is owing to this cause that the Spanish barrels never are so well finished on the outside as those of the English and French.

Alonzo Martinez de Espinar, arquebus bearer to Philip IV. in a treatise which he wrote upon this subject, informs us, that *Juan Sanchez de Mirvena*, gunsmith to Philip III. and the ablest artist of his time,

time, was the first who forged barrels in separate pieces, as well as the inventor of several instruments for dressing and finishing them with greater accuracy. Speaking of the barrels of this artist, he says, "*hicieronse grandes pruebas en ellos, y fueron conocidos por los mejores;*" they sustained extraordinary proofs, and were acknowledged superior to all others. He does not, however, inform us what these extraordinary proofs were; but says of the Madrid barrels in general, that in his time they were proved, after being finished within, and before they were filed, with a charge of powder equal to the weight of the ball which fitted their caliber, and four times this weight of large shot; and, that this proof was repeated three times.

The Spanish barrels are generally from three to three and a half feet long; their caliber from 22 to 24 *, and their weight

* In speaking of the size of the caliber, we mean by 22 or 24, that so many balls exactly fitting it weigh just one pound; and every caliber is marked in the same way.

from

from three to three and a half pounds. The reinforced part extends two-fifths the length of the barrel. At ten or twelve inches from the breech is placed a *fight*, such as is usually put upon rifle barrels, or upon those intended to shoot ball only, and the muzzles are in general a little bell-mouthed. Formerly the Spanish barrels were made much heavier than at present; and they ought, according to Espinar, to weigh at least four pounds and a half, if forty inches long, and of the caliber we have mentioned. For some years past, however, they have made them much shorter than this, and they now rarely exceed three feet.

The Spanish gunsmiths pique themselves upon the very high polish they give to the inside of their barrels. We have already expressed our doubts about the advantage derived from this, and are still of opinion, that if a barrel is so smooth as not to *lead**,

* A barrel is said to *lead*, when it is so rough within, that, after firing, the places where the ball or shot rubbed in their passage can be perceived, by part of the lead being left upon them.

it is better to take it as it comes from the hand of the manufacturer, than allow the gunsmith to practise any farther operation upon it : in support of this opinion, Mons. de Marolles informs us, that he has seen a barrel rough from the borer, throw a charge of shot deeper into a quire of paper, than another barrel that was highly polished within, although the length, the bore, and the charge were the same in both.

Notwithstanding the great reputation of the Spanish barrels, however, they are little used in France, and still less in England ; their awkward form, and their great length and weight, being strong objections to them, especially since they have begun to make their pieces so very short and light in these countries. And from our own experience of the Spanish barrels, we are convinced, that the avidity with which they are sought after by some persons, and the extravagant prices that are given for them, proceed more from a *fancied*, than from any *real* superiority they possess over those made in this country.

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As the Spanish iron, and especially that of Biscay, is acknowledged to be of a very superior quality, and as there is every reason to believe that the reputation of the Spanish barrels is more owing to this than to any superior excellence of the workmen; Monsr. de Marolles informs us that they have tried to work it at Paris, but that hitherto the French workmen have not discovered the precise degree of heat it requires, which is, no doubt, different from that found to suit the French iron. This, he says, he has learned from the workmen themselves; but he at the same time observes, that this difficulty is very probably owing to their using pit-coal, or coaks, whilst the Spanish workmen employ only the charcoal of wood; and that, to weld the Spanish iron, a much more moderate heat is required than what is afforded by pit-coal, and, perhaps, conducted also in a manner unknown in France. He adds, moreover, that, as workmen are obstinately attached to the methods they have been long in the habit of practising, it is not

to be wondered at if they should miscarry in their first trials of any new scheme; but that an expert and intelligent workman, who took the necessary pains, would no doubt succeed where others had failed, and this either by employing the charcoal of wood, or studying the proper management of the fire where *coaks* are used. In confirmation of this, we know that Spanish iron has been wrought in England, without any of the difficulties which the French workmen are said to have met with, notwithstanding that *crude* pit-coal alone is employed here.

The Spanish iron, owing either to its scarcity or high price, is not much employed in this country. During the late war, some gunsmiths procured it in tolerable quantity, by purchasing from the agents of Spanish prizes the barrel hoops, which, either from the cheapness of iron in *Spain*, or the want of flattening mills, &c. are unnecessarily thick and clumsy: this iron had also the advantage of being better wrought, and purified by the repeated heatings and

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hammerings required to form it into hoops.

The barrels of *Lazaro Cominazzo*, called after the maker, *Lazarini*, were formerly celebrated throughout the greatest part of Europe. They were very long, and of a very small caliber. Cominazzo lived at Brescia, about a hundred and fifty years ago. He did not forge these barrels himself, but he finished them with great accuracy, and ornamented them in a very rich and elegant manner. At the time, however, when these barrels were in high estimation, there were numerous counterfeits bearing the name and mark of Cominazzo; and it requires some acquaintance with the genuine barrels not to be deceived by the spurious ones. The true *Lazarini* are now to be found only in the repositories of the curious:

The vanity of possessing something that is singularly curious, the false idea that whatever is expensive must necessarily be good, and sometimes, though rarely, the laudable desire of improvement, have all in their turns been the causes of a variety of
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experiments being made in the manufacture of barrels. An artist * of this city, whose superior excellence in this branch deserves to be known to every sportsman, for many reasons that might be pointed out, informs us, that he has wrought a great deal of Spanish iron ; that he has forged barrels from old scythes, from wire, from needles, and a great many other articles suggested by the whim of his customers ; he has also made barrels with a lining of steel, and formed others with a double spiral of steel and iron alternately ; but that, as far as he can determine from these numerous trials, the stub iron wrought into a twisted barrel is superior to every other. Wherever steel was employed, he found that the barrel neither welded nor bored so perfectly as when iron alone was used.

* Mr. Fuller, of St. John-Street, Clerkenwell.

CHAP. IV.

Proofs of Barrels.

THESE differ in different countries. The Spanish proof, which has already been mentioned, is a very severe one; but as it is made before the barrel is filed and dressed on the outside, it is not satisfactory. At the royal manufactories of St. Etienne and Charleville, in France, there are inspectors appointed to see that no barrels are sent out of these places, whether for the king's use or for public sale, without being proved. The first proof is made with a ball exactly fitting the caliber, and an ounce of powder. The second is made with the same sized ball, and half an ounce of powder. The reason given for the second proof is, that the first may have strained the barrel so much, though the injury be not visible, that

that it will not bear a second trial with a smaller charge ; and it is said there really are some of these barrels which stand the first proof, and yet give way in the second. Fowling-piece barrels, both single and double, are proved only once, with half an ounce of powder and a ball fitting their bore.

The usual proof of the Paris barrels is a double charge of powder and of shot ; that is, two, or two and a half drachms of powder, and two, or two and a half ounces of shot. The English Tower proof, and that of the Whitechapel company incorporated by charter for proving arms, are made with a ball of the caliber, and a charge of powder equal in weight to this ball: the proof is the same for every size and species of barrel, and not repeated.

Some gunsmiths pique themselves upon making their barrels undergo a second proof ; but it is proper to observe, that if a barrel bears any assigned proof, it will sustain the same immediately after, with greater safety than it did at first, as the metal,

from being warmed by the first fire, expands more readily to the force of the second explosion.

Monf. de Marolles, speaking of the proofs of barrels, says, "A stronger proof than ordinary might be made by ramming down at top of the powder, six or eight inches of dry clay, in place of a double charge of lead. This is sometimes employed in proving pieces of ordnance, where, instead of the bullet, two feet of clay is placed over the powder, by which the whole force of the explosion is exerted upon the piece." We entirely agree with the ingenious author of *La Chasse au Fusil*, in the opinion, that the proof he mentions would be *much* stronger than that which is usually employed; so *much* stronger, indeed, that we do not believe any barrel could withstand it, unless the clay was put down in the loosest manner possible. The hardest rocks are burst asunder by means of dry clay strongly rammed over the powder that is placed at the bottom of a cylindrical cavity made in them; and we certainly cannot

not expect that a force sufficient to rend in pieces immense blocks of granite, can be resisted by the comparatively trifling strength and thickness of a gun barrel.

CHAP. V.

Causes of Bursting.

IT may be safely asserted, that a good barrel very seldom bursts, unless it be charged too highly, or in an improper manner. Whenever, for example, from the ball not being rammed home, a space is left between it and the powder, there is a great risque of the barrel bursting on being discharged. We say *a great risque*, because, even under these circumstances, it frequently happens that the barrel does not burst. If the ball stops near to the powder, a very small *windage* is sufficient to prevent this accident; and it is very rare that the ball touches the barrel in every part of its circumference, unless it has been driven in by force with an iron ramrod, in which case it moulds itself to the cavity, and blocks it up
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completely. Should this happen, the barrel, however strong it is, will burst, even when the space between the ball and the powder is but very inconsiderable ; and the greater the space that intervenes, the more certainly will this event take place. Mr. Robins, when speaking of this matter, says, " A moderate charge of powder, when it has expanded itself through the vacant space and reaches the ball, will, by the velocity each part has acquired, accumulate itself behind the ball, and will thereby be condensed prodigiously ; whence, if the barrel be not of an extraordinary strength in that part, it must infallibly burst. The truth of this I have experienced in a very good Tower musquet, forged of very tough iron ; for, charging it with twelve penny-weights of powder, and placing the ball (loosely) sixteen inches from the breech ; on the firing of it, the part of the barrel just behind the bullet was swelled out to double its diameter, like a blown bladder, and two large pieces of two inches long were burst out of it."

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The same accident will often take place from the mouth of the piece being filled with earth or snow, as sometimes happens when we are leaping a ditch with the muzzle of the piece pointed forwards; and if in such cases the barrel does not burst, it is because these foreign bodies stop it up but very loosely. For the same reason a barrel will certainly burst, if fired when the muzzle is thrust into water but a very little depth below the surface; the resistance given to the passage of the inflamed powder through the mouth of the piece being, in this case, much greater than that afforded by the sides of the barrel.

Except in the circumstances mentioned, or in case of an overcharge, it is, as we have before observed, very rare that a barrel bursts. Whenever it happens independent of these, it is from a defect in the work, and that either the barrel has been imperfectly welded, or that a deep flaw has taken place in some part of it; or lastly, that, through want of care in the boring or filing, it is left of unequal thickness in its sides.

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The last defect is the most common, especially in low-priced barrels; and as pieces more frequently burst from it, than from the other defects, it ought to be particularly guarded against. The elastic fluid which is set loose by the inflammation of the powder, and which endeavours to expand itself equally in every direction, being repelled by the stronger parts, acts with additional force against the weaker ones, and frequently bursts its way through them; which would not have been the case, had the sides been of the same thickness and strength, and not afforded an unequal repercussion. The weakness of any part of the barrel, occasioned by the inequality of the caliber, will still more certainly be the cause of bursting, than that produced by the filing; because, the inflamed fluid being suddenly expanded at the wider part, must suffer a compression before it can pass onward, and the whole force is then exerted against the weak place; for gunpowder acts in the radii of a circle, and exerts the same force on every part of the circumference of the circle.

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The conclusion to be drawn from all this is, that a thin and light barrel which is perfectly *upright*, that is, of equal thickness in every part of its circumference, is much less liable to burst than one which is considerably thicker and heavier, but which, from being badly filed or bored, is left of unequal strength in its sides.

In all that we have hitherto said upon the causes of bursting, the bad quality of the iron has not been taken into account, because we have supposed that the persons for whose information this Essay is chiefly intended, do not either purchase or use very ordinary barrels; and we do not know any means of ensuring against the defects of a barrel, whether arising from the badness of the metal, or from the insufficiency of the workmanship, except by purchasing from a gunsmith of established reputation, and giving a good price for the piece. But by this we do not mean to sanction the practice of many of the gunsmiths in the fashion of the day: we are confident in our opinion that most of their barrels are made
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toothin; and it may fairly be doubted whether they have at all improved the quality of the metal. In some experiments which we made with a barrel of the celebrated *Lazaro Cominazzo*, whom we have before had occasion to mention, and which was five feet ten inches in length, and extremely thin, particularly towards the muzzle, it was observed, that the barrel vibrated so much after the explosion of the charge, as to produce a whizzing or ringing sound that might be heard to a considerable distance from the barrel. And yet this piece, notwithstanding its extreme thinness, was fired with very high charges. The iron appeared to be of an extraordinary fine quality, which goes to prove that the cohesion of the particles of the metal is the force which resists that of the powder; and hence great advantage might be drawn to the manufacture of barrels, from an accurate knowledge of the force of powder, and the velocity of the ball. For these points being once determined, it might be known how strong the barrel should be, by which all unnecessary waste of metal might be

be spared on the one hand, and all danger avoided on the other. For a force equal to that which impels the ball is exerted on the inside of the piece; and if the barrel has not sufficient strength to resist this force, it must of necessity burst. In the examination of those principles, some authors of great eminence and authority have asserted, that the greatest force which the piece has to withstand, is at the first instant of the explosion before the ball sensibly moves out of its place, and that this force constantly diminishes as the ball approaches the muzzle: on this subject however we reserve our opinion for a subsequent discussion.

CHAP. VI.

Of the Recoil.

IN fire arms of every species, the explosion is invariably attended with a greater or less retrograde motion of the piece ; this is termed the *recoil*. It is only, however, when it is *excessive*, that it becomes an object of attention to the sportsman, or renders it necessary to determine the causes from which it arises, so as to enable the gunsmith to avoid or remove them. The most frequent cause of excess in the recoil is, the bore of the piece being wider at one place than at another ; for although this inequality be so small as to be imperceptible to the eye, the repulse which the expanding flame meets with when passing from the wider to the narrower part, renders the recoil much greater than it would have been had the

bore been perfectly cylindrical. It is an invariable law in mechanics, that *action and reaction are equal*; it follows, therefore, that *the weight of the piece being the same, the recoil will be in proportion to the quantity of the powder, and the weight of the ball or shot*; and that, *with the same charge, the recoil will be in proportion to the weight of the piece*; or, *the lighter the piece, the greater the recoil*.

In plainer language, the impelling force of the gunpowder is the first and most simple cause of fire arms recoiling; for this force acts equally on the breech of the piece and on the ball; so that if the piece and ball were of equal weight, and other circumstances the same, the piece would recoil with the same velocity as that with which the ball issues out of the piece.

For the same reason, whatever retards the exit of the charge operates like an increase of lead, and, by confining the force of the explosion the more to the barrel, produces a greater recoil; hence partly it is, that in proportion as the barrel becomes foul within
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by repeated firing, the recoil increases. A piece will recoil, if, from the breech-plug being made too short, there remain some turns of the screw not filled up; these hollows, wherein a part of the powder is lodged, forming an obstacle that confines and retards the explosion. A barrel mounted on a stock that is very straight, will recoil more than when mounted on a stock that is considerably bent, as the curvature serves to break and deaden the force of the recoil: and, sometimes also, a fowling piece will recoil from the shooter applying it improperly to his shoulder; for if the butt is not applied closely to the shoulder, or is applied so as to be supported only at a single point, the recoil will be much more sensibly *felt*, than when the hollow of the butt embraces the shoulder, and is firmly supported by the weight of the body. Guns are observed to recoil more after being fired a number of times, than they did at the beginning. The matter which is left upon the inside of the barrel after the explosion, and which increases on every discharge, attracts moisture

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very quickly ; especially if the saltpetre employed in the powder was not well purified from the admixtures of common salt which it contains in its rough state. This moisture becomes considerable after a few discharges, and, being formed into vapour by the heat, during the explosion adds its expansive effort to that of the inflamed powder, and greatly increases the agitation and recoil. Owing to this cause, probably, rather than to that before mentioned, arises the recoil from some turns of the breech-screw not being filled up by the breech-plug, and thereby affording a lodgment to moisture.

Among the variety of causes to which the excessive recoil of pieces has been attributed, there is one which yet remains to be considered ; this is, the touch-hole's being placed at some distance from the breech-plug, so that the powder, instead of being fired at its base, is fired near the centre of the charge ; whence, it is said, the recoil is increased, and the force of the discharge weakened, by the effort of the powder being exerted more upon the breech than upon the ball

or shot. With this idea in view, some gunsmiths form a channel or groove in the breech-plug, as deep as the second or third turn of the screw; the touch-hole opens into this channel, and the powder is thereby fired at its very lowest part; and this, they assert, increases the inflammation and the force of the powder. That the distance of the touch-hole from the breech, however, has very little, if any share in the increase of the recoil, we shall prove in the most satisfactory manner from experiments made purposely to determine this matter. As to the idea, that the force of the discharge is *diminished* by the *increase* of the recoil, it is too absurd to require discussion: the force exerted by the powder upon the breech, is always equal to that which it exerts upon the ball or shot; so that if there be nothing in the barrel that retards the exit of the ball, an increase in the recoil will be always attended with an increase in the force of the discharge.

The following experiments were made by
Monf. Le Clerc, who is gunsmith to the

king of France, and well informed upon every subject that relates to his profession ; they were communicated by him to Monsr. de Marolles.

These experiments were made with a barrel which was 30 French inches in length (nearly 32 English measure), and weighed, together with the loaded plank upon which it was fixed, twenty-eight pounds. The barrel had four touch-holes which could be stopped with serews. The charge consisted of one drachm and twelve grains of powder from a royal manufactory, and of one ounce eighteen grains of shot called *small 4*. This was fired at a sheet of paper measuring 20 inches by 16, French measure ; placed at the distance of 28 toises, or nearly 45 ordinary paces. The only difference was, that in the first set of experiments the wadding consisted of card-paper, and in the second of hat, both cut to fit the caliber.

Had these trials been made with no other view than to determine the degree of recoil produced by the different situation of the touch-hole, there would have been no use

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in marking the size of the shot, the distance and dimensions of the mark, and the number of grains thrown into it at each discharge. It was, however, intended to try at the same time, how far the equality of the discharges could be depended upon, with regard to the number of grains that struck a given space; and we shall have occasion hereafter to make some remarks upon the result of the trials in this respect.

N. B. The French foot is three quarters of an inch longer than the English foot, and the French *inch* is divided into twelve *lines*.

We have thought it better to inform the reader of this, and leave the table as it is, than make any fractions in the numbers by reducing it to English measure.

First Set.—Wadding of Card-paper.

	Dis-charge.	Recoil.			No. of grains thrown into the mark.	
		Foot Inch. Lines			Mean.	
Touch-hole close to the breech-plug.	1	1	0	3	Mean 36 14 31	27
	2	0	10	3		
	3	1	0	3		
Touch-hole two lines from the breech-plug.	1	1	3	9	45 33 26	34
	2	1	2	0		
	3	1	3	3		
Touch-hole six lines distant.	1	1	0	10	38 20 18	25
	2	0	11	11		
	3	1	0	9		
Touch-hole twelve lines distant.	1	1	1	7	27 17 35	26
	2	1	0	3		
	3	1	1	4		

Mean of all.
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Extremes 0. 10. 3 & 1. 3. 3—Mean recoil 1. 1. 0—Extremes 14 & 45

Second Set.—Wadding of Hat.

Touch-hole close to the breech-plug.	1	1	1	1	40 78 37	51
	2	1	4	0		
	3	1	2	0		
Touch-hole two lines distant.	1	1	0	7	44 40 41	41
	2	1	2	3		
	3	1	3	3		
Touch-hole six lines distant.	1	1	3	3	32 50 53	45
	2	1	2	9		
	3	1	3	2		
Touch-hole twelve lines distant.	1	1	4	5	60 11 51	44
	2	1	2	7		
	3	1	2	5		

Mean
45

Extremes 1. 0. 7 & 1. 4. 5—Mean recoil 1. 2. 8½—Extremes 21 & 78

From

From these experiments it appears, that, with regard to the *recoil*, the distance of the touch-hole from the breech is of little importance. The only circumstance, therefore, to be attended to in its situation, is, that it be not placed quite close to the breech-plug; for although that part of the barrel where the powder is lodged, dirties much less than a few inches farther forward, yet the touch-hole when close to the breech-plug, is found to be more frequently stopped up than when situated about a quarter of an inch from it.

CHAP. VII.

Range of Barrels.

THE lightness of fowling pieces of a moderate length, and the ease with which they are managed, are advantages so obvious, and at the same time so considerable, as to give them a general preference at this time; but as the circumstances upon which only this preference ought to be rested are little known, it is not sufficient that their use is general, and daily increasing, unless it be determined what are the comparative excellencies and defects of long and short barrels, and it be thence shewn whether sportsmen sacrifice one advantage to gain another.

It is not more than fifty years since it was first suggested as a doubt, whether long barrels carried farther than short ones. Formerly every sportsman was provided with
pieces

pieces of different lengths: the shortest was from 30 to 34 inches in the barrel, and was employed for shooting in cover, where a long piece would be inconvenient; whilst that for the open country was from 42 to 45 inches in the barrel.

The generally received opinion upon this subject is, that, to obtain an increase in the range, the barrel must not only be made longer than usual, but that the length and the diameter of the bore ought to bear a certain proportion to each other, and the charge of powder be suited to this proportion; because, as it is said, when the barrel is too short, the ball or shot quits it before it has received the whole impulse of the powder; and, on the other hand, when the barrel is too long, that the powder is not only all inflamed, but even partly consumed, before the ball or shot arrives at the mouth of the piece. It was upon this theory that Balthazar Killar, a celebrated cannon founder in the reign of Louis XIV. rested his opinion, when asked by Monsr. Suriry de St. Remy, whence it was that the culverin of
Nancy,

Nancy, which was 22 feet in length, did not carry a ball as far as a shorter piece was found to do: his answer was—"The powder when inflamed ought to quit the cavity of the piece in a certain time, in order to exert its whole force upon the bullet; by a longer stay part of the force is lost; and the same cause may produce an inequality in the shots, by giving a variation to the bullet, so as to destroy its rectilinear course, and throw it to one side or other of the mark." See *Memoires d'Artillerie de St. Remy*, tom. i. p. 117.

Such also is the reasoning employed by Nicola Spadoni, who has treated expressly upon the subject of fowling pieces, in a little work entitled *La Caccia dello Schioppo*. This author even goes so far as to determine the exact proportion that ought to obtain between the length and the caliber of gun barrels, and then proceeds to assign the quantities and qualities of the powder and shot suited to these respective dimensions. He is of opinion, that the powder should be coarser grained for long and wide barrels, than

than for such as are short and of a small caliber, and this in proportion to the space it has to pass through in the one and in the other; he thinks the grains ought to be larger for long pieces, because in these more time is given for the powder to be inflamed; and that where large grains are completely inflamed, they act with greater force upon the ball or shot than small ones do. Lastly, he says, the powder should be fine for short barrels, because the small grains inflame more suddenly than the large ones.

In order to prove that the large grained powder is stronger than the fine kind, he mentions the circumstance of powder having its explosive force diminished by the grains being broken down, or ground into *meal powder* as it is called *.

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* It is a well known fact, that the explosive quality of powder is almost destroyed by the powder being ground fine; but it does not follow from thence, that large grained powder is stronger than that which is small in the grain; on the contrary, it would appear even from Spadoni himself, that the latter is the stronger, for he allows that it inflames more rapidly. The committee

With regard to the shot, he prefers that of a large size for long barrels ; because, he says, the grains by their weight oppose a greater resistance to the powder, and by their diameter acquire a greater velocity *.

Spadoni

mittee of the Royal Society appointed to examine the position of Mr. Robins, *that all the powder was inflamed before it left the barrel*, found, that the particles collected after the explosion were much fewer when the powder was sifted, and the small grains only employed: as the *inflammation*, therefore, was more complete, so we would conclude the *force* of the explosion to have been greater in the one case than in the other ; and consequently that small grained powder is the best for every sized barrel. Some further remarks on this subject are, however, introduced in a subsequent part of this work, and to which the reader is referred.

* As long barrels are intended for killing at a distance, Spadoni is right in preferring large shot for them, but not on account of the reasons he has assigned ; because they neither oppose a greater resistance to the powder, nor are they projected with greater velocity. The grains, whether large or small, pass through the barrel with equal velocity, provided the quantity of powder, and the *weight* of the shot employed, be the same. The distance to which they fly, however, will be very different ; for as the resistance opposed by the air is in proportion to the surface, the whole retard-
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Spadoni has formed a table, in which he has set down the proportions he so strongly insists upon ; but as his deductions are mostly drawn from false premises, his arguments, however specious, ought not to weigh against those that are rested upon established principles, and which are found to bear the test of experiment.

From the theory of which we have just given a detail it appears, that the superior range of long barrels was founded entirely upon the opinion, that *the powder fires gradually all the time it is passing through the barrel.* The conclusion necessarily drawn from this was, that the larger the charge, the longer time it was in kindling ; and hence, that *for any assigned charge, the barrel must be of a proportional length, so that the powder may*

ing force (which arises from a comparison of the resistance with the quantity of matter to be moved) will be exactly in the inverse proportion of the diameter of the different sized shot employed : hence a musquet ball of an ounce weight, fired with one sixth its weight of powder, will range nearly twice as far as a pellet weighing but one eighth of an ounce, fired with the same proportion of powder.

be completely inflamed just as the ball or shot are about to quit the muzzle. The converse of this proposition was, that in every piece there is a certain charge which will be all fired just at the parting of the ball or shot from the mouth of the piece, and that any addition of powder will not take fire, but will only serve, by its weight, to diminish the action of the rest, and, consequently, to retard the velocity of the shot or ball.

If this matter be considered with mathematical rigour, it must certainly be allowed, that, as the fire is not at once applied to every particle of the powder, the whole of the charge cannot be inflamed at the same instant; but it is equally certain, that the progress of the inflammation is so rapid, that the powder is completely kindled before the ball or shot arrives at the mouth of the shortest barrel ever made use of.

To determine this, a number of experiments were made by a committee of the Royal Society, so long ago as the year 1743*;

* Philosoph. Transact. No. 465. p. 172.

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and by these it was shewn, that, when a barrel was shortened so much that the ball placed before the powder was upon a level with the muzzle, the unfired powder, collected from the discharge by means of a cloth spread before the piece, weighed but one *twelfth* of the charge. This was analysed, and found to contain less saltpetre than an equal portion of the same powder did. Hence, and from the extreme minuteness of the particles collected, there was reason to believe, that the grains to which they belonged were less susceptible of inflammation than the rest, owing, perhaps, to some inequality in their mixture: what served in a great measure to prove this, was, that when the charge, and consequently the heat generated during the explosion, was increased, the quantity of unfired powder collected was proportionally smaller. And we may therefore safely conclude, that *the powder is completely inflamed before the ball or shot arrives at the mouth of the shortest barrel ever employed.*

Having now removed the ground upon
which

which the superior range of long barrels was formerly rested, it is necessary that we should endeavour to shew upon what circumstances it does really depend, and to what extent it is found to take place.

The elastic fluid produced by the firing of gunpowder is found, by experiment, to occupy, when cooled to the temperature of the atmosphere, a space 244 times greater than that taken up by the powder from which it was obtained. But from the heat generated during the explosion, this elastic fluid is rarefied to upwards of four times its former bulk. The expansive force of this fluid, therefore, is, at the moment of inflammation, *one thousand* times greater than that of common air, or, which is the same, than the pressure of the atmosphere; or, supposing the powder to have occupied the space of one cubic inch, its expansive force, when fired, is equal to that which would be exerted by *one thousand* cubic inches of common air compressed into the space of *one* inch.

As the velocity with which the flame of
gun-

gunpowder expands when uncompressed, is much greater than that with which the ball, or shot, moves forward, the flame must continue to press upon the ball, and add to its velocity, until it quits the mouth of the piece. This pressure, however, becomes less and less, as the ball proceeds, and ceases entirely when it leaves the muzzle, in consequence of the flame being then allowed to expand itself laterally. Thus, for example, if the charge of powder takes up *one* inch of the barrel, and the whole length of the barrel be *thirty* inches, then, when the ball arrives at the muzzle of the piece, the inflamed powder (whose expansive effort is in proportion to the smallness of the space it occupies) extends through *thirty* times the space it did when the ball began to move, and consequently presses forward with but *one-thirtieth* part the force it possessed at first. Moreover, although the *velocity* of the bullet is continually increased by this pressure of the inflamed powder, its *acceleration* becomes less and less as it proceeds through the barrel; for besides

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that the quantity of the pressure diminishes as the flame expands, the bullet continuing to move faster and faster, must receive continually less and less addition of impulse from the flame pressing behind it. Hence, if two pieces of the same bore, but of different lengths, are charged with the same quantity of powder, the longer piece will, strictly speaking, communicate the greater velocity and force to its ball, or shot. But as the inflammation of the powder has been shewn to be *nearly* instantaneous, and as the increase of acceleration which the ball or shot receives after the first impulse of the powder upon it, is not very considerable; it follows that the force with which two barrels of the same bore, and with the same charge, throw their ball or shot, will be nearly the same, unless their lengths be *extremely* disproportionate.

To prove this, and to corroborate the experiments made by ourselves upon the subject, we shall quote what is said by that able mathematician and engineer, the late Mr. Benjamin Robins, to whose work we

are indebted for much valuable information.

“ If a musquet barrel of the common
“ length and bore, be fired with a leaden
“ bullet and half its weight of powder, and
“ if the same barrel be afterwards shortened
“ one half, and fired with the same charge,
“ the velocity of the bullet in this shortened
“ barrel will be about *one-sixth* less than
“ what it was when the barrel was entire ;
“ and if, instead of shortening the barrel, it
“ be increased to twice its usual length
“ (when it will be near eight feet long), the
“ velocity of the bullet will not hereby
“ be augmented more than one-eighth part.
“ And the greater the length of the barrel
“ is in proportion to the diameter of the
“ bullet, and the smaller the quantity of
“ powder, the more inconsiderable will
“ these alterations of velocity be.”

When the allowances which Mr. Robins here takes notice of, are made in the proportion required for fowling pieces, the result will be found to correspond exactly with the experiments which we have re-

peatedly made; with every possible attention to accuracy. We have, at different times, compared barrels of all the intermediate lengths between 28 and 40 inches, and of nearly the same caliber, that is to say, from 22 to 26; and these trials were made both by firing the pieces from the shoulder, and from a firm block, at an equal distance, and with equal weights of the same powder and of the same shot.

To avoid every possibility of error, the quires of paper at which we fired, were fixed against planks, instead of being placed against a wall. From these trials frequently repeated, we found that the shot pierced an equal number of sheets, whether it was fired from a barrel of 28, 30, 32, 34, 36, 38, or 40 inches in length. Nay more, we have compared two barrels of the same caliber, but one of them 33, and the other 66 inches long, by repeatedly firing them in the same manner as the others, at different distances from 45 to 100 paces, and the results have always been the same, *i. e.* the barrel of 33 inches drove its shot
through

through as many sheets of paper as that of 66 did. The conclusion from all this, is, that the difference of *ten* inches in the length of the barrel, which seems to be more than is ever insisted upon among sportsmen, produces no sensible difference in the range of the piece; and therefore, that every one may please himself in the length of his barrel, without either detriment or advantage to the range*.

The

* As we have presumed to lay down the foregoing principles, and which we have ventured to adopt on the great credit of our countryman Robins; it is but fair to say, that he was in his own time, and has been since, very plausibly, if not ably, controverted by foreign engineers of great repute; and therefore it may not be altogether unacceptable to our readers, to give a brief statement of some of the arguments and experiments advanced in opposition to his doctrine. Robins, in his proposition for determining the velocity which a ball acquires from the explosion, assumes two principles: First, That the action of the powder on the ball ceases as soon as the ball is got out of the piece. Second, That all the powder of the charge is fired, and converted into an elastic fluid, before the bullet is sensibly moved from its place. From these prin-

The circumstance of a duck-gun killing
at a greater distance than a fowling piece,
is

ciples, if true, it would naturally follow, that a tolerable sized pistol would carry as far as a gun-barrel of an ordinary length—a position so absurd, that we cannot dwell on it a moment; or which leaves us to suppose that the powder which Robins used was so chemically excellent, that the greatest part of it in his experiments fired before the ball made its exit out of the shortest barrel. And yet we have reason to believe that this author, after the report made by the committee of the Royal Society appointed to superintend his experiments on this subject, qualified his former assertions, and admitted that some grains are often observed in the powder which resist the force of the flame some time before they fire. Indeed, the difficulty of ascertaining with certainty the complete inflammation of the powder must necessarily be very great; for it may happen that a considerable part of the powder is blown out unfired, yet fires before the muzzle, and is of no effect in impelling the ball, although these grains do not fall to the ground unfired: for the flame before the muzzle seems sufficiently fierce to fire and consume any part of the powder that did not fire in the barrel, by reason of its short continuance there. And may it not also be supposed that some small part of the charge is not rammed up with the rest, but is left in the piece before the wad, as well as that the gradual

is not owing to its *length*, but to its greater weight and thickness allowing the charge of

dual firing of powder must be different in different forts?

The following is an account of some experiments made by General Gunther at Petersburg, in presence of several members of the academy there, as well as of engineers of the first reputation, purposely to ascertain whether the total explosion of powder was, or was not, instantaneous: to which we have added a small abstract of the remarks and observations of an ingenious and learned commentator on the works of Euler, relative to the same subject.

The first experiment was made with a piece whose cylinder was $7\frac{7}{8}$ English feet long, which was fired vertically, with different charges of powder and a ball of the caliber. The time from the explosion until the ball's return to the ground was exactly observed by means of a pendulum; from which Mons. Bernoulli computed the velocity with which the ball issued out of the piece; and from the calculation he found that the piece being loaded with 1, 4, and 8 ounces of powder, the ball must have ascended in vacuo 541, 13694, and 58750 feet. Then $1\frac{7}{8}$ foot was sawed off the piece, so that the cylinder was exactly 6 feet long; the piece was then fired with the same charges of 1, 4, and 8 ounces of powder; and he found that in vacuo the ball must have ascended only 274, 2404, and 6604

G 4

feet;

of powder to be doubled, trebled, or even quadrupled; which cannot be done in a fowling

feet: so that the eight ounces of powder carried the ball nearly nine times higher before than after shortening the piece; and therefore the velocity with which the ball issued out of the piece must have been about three times greater in the first case than in the last.

But, according to the theory of Robins, the difference must have been scarcely perceptible; and hence it appears that, before the piece was shortened, a good part, indeed the greatest part, of the powder fired whilst the ball moved through the last foot and a half of the cylinder.

The same conclusion follows in the lesser charges, although the difference in them is not so great; and hence it likewise appears, that, the greater the charge is, the more time will be employed before it all fires; which of itself is almost self evident.

The rifled barrel, which is known to carry a ball much farther than a barrel not rifled, is another proof that the powder does not fire all at once; for, if it did, the rifled barrel would not carry near so far as the other. For, considering the great resistance the ball has to overcome in a rifled barrel, even if we neglect the motion of the ball round an axis, which requires a force to effect it, there cannot be the least doubt entertained about it; yet, notwithstanding this great resistance, a ball acquires a greater velocity when fired
out

fowling piece, though strongly reinforced.
For a barrel of five or six feet, such as that
of

out of a rifled than when fired out of a common barrel, when every thing else is the same. There must therefore be a much greater force exerted in a rifled than in a common barrel, to overcome the resistance, and also to communicate a greater velocity to the ball. This force is generated by the powder only, which is in both cases the same. There can be no cause assigned why the force should be greater in one than the other, except that in the rifled barrel all the powder, or at least the greatest part, fires before the ball quits the piece; and that a smaller quantity fires in a common barrel. The last argument seems to throw the greatest light upon the matter in hand, as it proves not only that the powder does not fire all at once, but that only a small portion of it commonly fires before the ball is out of the piece. For which reason the opinion of *Mons. Bernoulli* becomes the more probable, namely, that the elastic fluid generated by the explosion of the powder, has an elastic force near 10,000 times greater than the pressure of the atmosphere, notwithstanding that *Robins* makes it only 1000 times greater.

A variety of other experiments and arguments might here be introduced on this subject: but, as those we have just mentioned seem to comprise the principal objections to the doctrines of *Robins* in this controversy, we will not take up the time and patience of the reader

by

of a common duck-gun, weighing five or six pounds, and the whole piece twelve or thirteen pounds; may be fired with a very large charge, without recoiling so much as to hurt the shooter, its weight being sufficient to resist the violent impulse occasioned by the increase of the powder. But in a fowling piece of three feet barrel, sufficiently strong to withstand such a charge, and whose weight altogether does not exceed five or six pounds, the recoil would be insupportable. Besides, they not only double or treble the powder in a duck-gun, but they put in a much greater quantity of shot than is ever employed in a fowling piece.

Duck-guns are generally bent a little upwards near the muzzle, which, the gunsmiths say, makes them throw their shot farther than if they were perfectly straight.

To obtain, therefore, from a piece of the

by adducing any more, leaving him for the present to form what opinion he pleases, and declaring that at this time we cannot decisively say what is our own.

ordinary

ordinary length, the same effects as from a duck-gun, nothing more, perhaps, is necessary than to have the barrel sufficiently strong to admit of the charge being doubled or trebled as required, and the whole piece heavy enough to render the recoil supportable. We may here observe, however, that an increase of the powder above the charge generally used, does not produce a proportional increase of range in the ball or shot; thus a double charge of powder will not throw the ball or shot to twice the distance, nor a treble charge to three times the distance, the single charge does. This arises from the great resistance given by the air to the motion of the ball or shot, and which is proved to be fourfold if the velocity be doubled, and ninefold when it is trebled by an increase of the powder; for the resistance of the air is not proportional to the velocity itself, but only to the square of the velocity. Thus *Bernoulli*, a professor in *Basil*, discovered from experiment that a ball which, being fired, ascended only 7819 feet in the air, would ascend 58,750 feet in vacuo.

vacuo. Still we may safely infer, that, if the action of the powder is not diminished by circumstances of defect in the formation of the barrel, the greater the force of the powder, the greater must be the velocity of the ball.

So great is the change in opinion of late, with regard to the proper length for gun barrels, that many gunsmiths will now tell us, that short barrels carry *farther* than long ones; and the reason they give for this, is, the greater friction of the ball or shot in passing through a long barrel, by which their velocity is retarded and their force diminished. If the barrel be so long that the additional impulse which the ball or shot is continually receiving in its passage, becomes less than the friction between them and the sides of the caliber, then, indeed, the barrel by being shortened will shoot with more force: but as the length of barrel required to produce this effect, is vastly greater than can ever be employed for any purpose, the objection does not hold. And it seems clear, that a piece may be made so long that
it

it will not throw a ball with so great a velocity as one that is considerably shorter; and the reason of this decrease of velocity may be, that in very long pieces the increase of the counterpressure of the external air in the cylinder may greatly exceed the force of the powder, and that the elastic fluid generated by the explosion of the powder is constantly escaping whilst the ball passes along the cylinder, which it not only does at the touch-hole, but also between the ball and the sides of the barrel; and hence may be inferred the necessity of touch-holes which do not prime of themselves, and of wadding that stops the barrel hermetically.

Having now, we hope, thrown every light upon this question, that is necessary to determine us in our choice of the *length*, it will, perhaps, be expected that we give our opinion, what length of barrel is best calculated for general use. The barrels which we ourselves employ, and which we have found to answer best for every purpose, are from 32 to 38 inches; and whether we
consult

consult the appearance of the piece, its lightness, or the ease with which it is managed, we believe that a barrel not exceeding the one, or below the other of these numbers, is the most eligible. We know that many of the fashionable gunsmiths pique themselves on the proportions they give to the different parts of their fowling pieces, and thence deduce a superiority over their cotemporaries in favour of their own: to us it appears that the beauty of those proportions is more attended to, than any good reason why they are made so rather than otherwise.

CHAP.

C H A P. VIII.

On the Shot of Fowling Pieces.*

WE often hear of fowling pieces which throw their whole charge of shot into the breadth of a hat at the distance of forty or fifty paces; and so generally is this believed among sportsmen, that it is no uncommon thing to hear gentlemen telling

* We have here employed a word whose propriety, in the sense we have taken it, may certainly be disputed, but were obliged to do it for want of a better. By the *shot* of a barrel, we mean to express the closeness and steadiness with which it throws its charge of shot against any object; whilst the *range* relates to the *distance* to which a ball or shot is thrown, without considering whether it flies in a straight line or not: or it may be considered as relative to the excellence or the defect of a barrel's shooting. By way of distinction we have put the word *shot* in italics, when employed in the sense here mentioned.

the

the gunsmith, that they expect the piece they are ordering will do the same. It will therefore appear very extraordinary, if, in defiance of this general prejudice, and of the remarks so frequently made, that "this piece shoots extremely close," and "that scatters prodigiously," we should make it a question, whether some barrels throw their shot more closely than others do ; but still more so, if we decided the question with a negative, and this from various experiments, made on purpose, and frequently repeated in order to satisfy ourselves of the fact.

The few who have made this matter the subject of experiment, know that the closeness or wideness with which a piece throws its charge, is liable to an infinite number of variations ; and that, whether from circumstances that are merely accidental, or from others, which, being unknown, cannot be prevented, the grains of shot composing the charge, may, at the instant of explosion, arrange and combine themselves so differently, that all the trials they can make will never produce results sufficiently uniform to
draw

draw any general conclusion from, or to convince persons not already prejudiced, and who will take the trouble to examine before they decide.

We have fired the same piece from a rest, twenty times in succession, with the same charge of powder and of shot, and at the same distance ; and have, during the course of the firing, thrown into the mark from 30 to 70 grains, with all the intermediate numbers. We have repeated this trial a great many times with the same piece, and also with different pieces at the same time, without having ever observed so much uniformity in the same piece, or difference in different pieces, as to give room for preferring one piece to another. The experiments made by Monf. Le Clerc (see the table, page 70) serve to confirm these. It is worthy of notice, however, that in the second set of experiments, the number of grains thrown into the mark is uniformly greater than in the first set, although, as we have already mentioned, the only difference between them was, that, in the first set, the

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wadding

wadding was made of card-paper, and in the second, of hat, both cut to the size of the caliber: are we to attribute the difference in the results to this circumstance?

In firing with ball it is observed, that the better the ball fits the piece, or the less *windage* there is, the greater will be the force of the discharge. This evidently depends upon the flame not being allowed to escape past the ball; and probably in the case of shot the wadding of hat may be preferable to that of card or paper, by diminishing the windage; or rather, perhaps, by preventing the flame from getting among the grains of shot, and dispersing them by its lateral expansion when it has quitted the muzzle.

The first conjecture might be determined, by comparing the closeness or dispersion of different discharges, in some of which tow, in others paper or card, and in others hat, was employed for wadding. The second also might be decided by varying the situation of the piece of hat; thus, for instance, we might one time place it between the
7 powder

powder and shot, with a small wadding of tow over the shot; and at another time place the tow next the powder, and the hat over the shot. If the hat operated by preventing the flame escaping past the shot, and thus lessening the *force* of the discharge, there would be little, if any, difference whether it was placed above or below the shot. But if its good effects depend upon its hindering the flame from getting among the grains, and scattering them in the manner mentioned above, then the shot would fly more closely when the hat was placed between it and the powder. We are, however, inclined to consider the latter as the true effect of hat wadding, and this from a practice that is said to be secretly and successfully followed by some persons, when firing with shot at a mark, for a wager: they put in the shot in small quantities at a time, ramming down a little tow or thin paper over each, so as to fill the interstices of the grains, and thus prevent the flame from insinuating itself among them.

Another opinion pretty generally estab-

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lished

blished among sportsmen, and upon which we shall decide much in the same way we have done upon the former, is, that barrels of a small caliber throw their shot more closely than those of a wider one do. That the same number of grains spread over two unequal surfaces, and flying off from thence with equal degrees of divergency, will be found more widely separated in the one case than in the other at any assigned distance, is a circumstance mathematically true; but the difference in this case will never be greater than that of the respective surfaces from which they are diverged. Now the difference between the areas of the largest and smallest calibers ever employed in fowling pieces, is less than the error in the measurement of this divergence would be at ten yards from the muzzle; so that the greater or less diameter of the bore cannot produce any sensible difference in the closeness or wideness with which the shot is thrown, provided the charge be the same in both pieces. We have subjected this matter to the test of experiment, and the result has

has accordingly been, that a barrel of 22 or 24, which is the largest caliber usually employed in fowling pieces, threw its shot as closely as one of the smallest caliber, viz. of 30 or 32.

There is a curious circumstance attending the *shot* of barrels, which is, that sometimes the grains of lead, instead of being equally distributed over the space they strike, are thrown in clusters of ten, twelve, fifteen or more, whilst several considerable spaces have not a single grain in them. Sometimes a cluster of this kind consists of one-third, or one-half of the charge; and it also happens sometimes, though more rarely, that the whole charge collects itself into one mass, so as to pierce a board near an inch thick, at the distance of 40 or 45 paces. Small barrels are *said* to be more liable to this than large ones; and Mons. de Marolles says, that this is especially the case when the barrels are new, and also when they are fresh washed. He mentions a double-barrelled piece of 32 caliber, which was particularly liable to this *clustering* and *lumping* of the

shot ; but adds, that the same thing did not happen to him with other barrels of 26 and 28 caliber, which he had used before. The lumping may, perhaps, depend upon the wadding employed, acting somewhat in the manner we spoke of in page 99 ; possibly the *clustering* of the shot may proceed from the wadding doing the same, with a *part* of the charge. Our *conjectures* upon this matter, however, together with the means which we think most likely to remedy it, will come more properly under the head of the next article.

With regard, then, to the extraordinary closeness with which some pieces are *said* to throw the shot, we certainly shall not take upon us to assert that the persons who *speak* of them, wish to deceive us ; but we do most firmly believe that they deceive themselves ; and that their accounts proceed either from their belief that a gunsmith, by superior skill and care, is able to make such, or from their having once seen a piece accidentally *lump* its shot in the manner described above. The result of our experience,
how-

however, is very unfavourable to this prevailing opinion; for we do affirm, that, after having fired at a mark times without number, we have never yet found a barrel which, at the distance of 50 paces, would throw its whole charge with regularity, we will not say into the breadth of a hat, but, into a space of three feet square.

CHAP. IX.

*Of the Means which have been employed to
improve the SHOT of Fowling Pieces.*

FROM the prejudices which obtain so generally among sportsmen and gunsmiths, respecting the *shot* of pieces, it is very natural to suppose, that a variety of means have been sought after and practised, in order to remedy this real or pretended effect of scattering the charge. Mr. de Marolles mentions several methods employed for this purpose, none of which, however, appear to be practised in England; and indeed, if we may be allowed to judge of them *a priori*, we believe few gunsmiths here will have faith enough to make the experiment. One of the methods he describes is as follows: An iron or wooden mandril fitted to the caliber, is furnished at one end with
small

small files which are cut transversely only ; this instrument being introduced into the barrel is turned round by means of a cross-handle, and forms a great number of superficial scratches in the metal, by which, they pretend, the defect of scattering the shot is remedied. One obvious effect of this operation, is, that of destroying the smoothness of the barrel within, and thereby rendering it liable to dirty the sooner ; but we cannot conceive how the shot should be thrown closer by having the friction increased between it and the sides of the caliber ; and that this will be the case, is evident, from a rough barrel being always found leaded considerably after every discharge. Some make the barrel wider for three or four inches at the muzzle ; and this bell-mouthed form is of very ancient date.

Espinar, whose treatise has been already mentioned, says, he has generally found this succeed in making barrels throw their shot closer. Were this true, we should expect to find this form of the barrel more generally used than it is at present, and not hear

so many complaints among sportsmen about their pieces. We cannot ourselves perceive the slightest ground for preferring it; nay, we are decidedly of opinion that it is rather of disadvantage to the *shot* of the piece, and for the following reasons: As hat is seldom employed for wadding, it is scarcely possible, but that more or less of the flame will escape past the wadding of tow or paper, and insinuate itself among the grains of shot; this flame will expand itself laterally as soon as it arrives at the widened part, and, by driving the grains along the sides of the muzzle, will communicate a whirling motion to them, that will increase their divergency very considerably *.

When we consider that the grains of shot which are in actual contact with the sides of the barrel, compose upwards of half the charge, we cannot be surprised if enlarging the surface of the caliber at the

* The principles upon which this circumstance is accounted for, will be explained very fully when we come to treat of rifle barrels, and the causes of variation in the flight of balls and shot.

muzzle,

muzzle, and thereby increasing the number of grains that touch it, will tend to make the shot be scattered more widely. Espinar says that the fault of scattering the shot is not owing to the hand of the workman, the barrels of the best masters being equally subject to it as those of others. He is of opinion, that it arises from the different quality of the iron composing the several portions of the barrel. Thus, he says, it may happen that the reinforced part is formed of iron which is harder, and closer in the grain, than that forming the fore part of the barrel; in consequence of which, and also from the fore part being so much thinner, the latter is the more shaken by the powder, and by that means produces a dispersion of the shot. He therefore pretends, that widening the muzzle in the manner already spoken of, by facilitating the explosion, diminishes the force of the powder upon this part, and causes the shot to be thrown more closely together.

This opinion of Espinar, however, not only appears absurd in itself, but there is

not

not even the smallest ground for it in the greater number of instances ; the barrels which are forged in separate pieces being very few indeed, compared with those that are forged in a single piece, and are consequently of the same quality throughout : nor does it appear that the former are more liable to the fault in question, than the latter are.

Some gunsmiths, says Monf. de Marolles, pretend, that a barrel, in order to throw its shot closely, ought to have its caliber narrower in the middle, than at either the breech or muzzle ; whilst others, again, insist that the caliber ought to contract gradually from the breech to the muzzle. With respect to these contrivances, however, we shall only observe, that they are both admirably calculated to make the piece recoil, if not to burst it.

The straight rifling of barrels, is an expedient, which, though not often practised, yet deserves notice, as having the testimony of some amateurs to its efficacy in preventing the scattering of the shot. Neither the
work-

workmen who make these pieces, however, nor the persons who use them, can give any satisfactory explanation of the principles upon which the rifling proves serviceable in fowling pieces; and some of them admit that it cannot be of any use, unless the depth and breadth of the channels, and the size of the shot, are suited to each other. Having never tried any of these pieces, we shall not assert, that they possess *no* advantage over the plain ones; but we can safely say that they are attended with several obvious inconveniencies, the chief of which is, their great weight; for the barrel must be made considerably thicker than a plain one, in order to admit of being rifled, and the additional quantity of metal in it, when finished, will be in proportion to the depth of the channels, and the breadth of the threads. They are also more difficultly kept clean; and it is scarcely possible to prevent a considerable windage, let us use what kind of wadding we will: so that not only a part of the *force* of the explosion will be lost, but the flame,
by

by getting among the grains of the shot, will increase their divergency from its lateral expansion when the charge has quitted the muzzle. We shall, however, postpone the farther consideration of this matter, until we have treated of rifle barrels in particular, when it will be better understood, and more in its proper place.

Of all the contrivances which have been mentioned, not one appears calculated to answer the end for which it was proposed. The greater number of gunsmiths are sensible of this, and therefore very seldom practise them, unless to indulge the whim of their customers. As far as our reason and experience are sufficient for enabling us to determine upon the matter, we would reject all the expedients that have been hitherto proposed, and give a decided preference to the barrels as they are usually made, *i. e.* to those whose caliber is very smooth and perfectly cylindrical throughout. Barrels of this kind have long supported their credit among the best sportsmen, whilst the pretended improvements have all experienced
but

but a very temporary reputation, and are now almost entirely neglected.

• Would sportsmen only forbear to determine upon the merits or defects of their pieces, until they had given them a patient and impartial trial, by varying the quantity of powder and shot in different ways; we are inclined to think there would be fewer complaints made of the modern fowling pieces. We can assert from our own knowledge, that several gentlemen have hastily parted with their pieces, and thrown a censure upon the maker, which after-experience proved to be undeserved: and we have prevented several of our acquaintance from doing the same, by prevailing upon them to make a farther trial with different charges. The chief source of error appears to be, that of overcharging; and it was generally by correcting this, that we succeeded in removing the bad opinion which had been entertained of many pieces. Every barrel, according to its caliber and weight, has a certain quantity of lead, and a suitable one of powder, which will be attended with greater
cer-

certainly and effect than any others ; and these must be determined by repeated trials. If we increase the quantity of shot above this, we lessen the force of the discharge, and at the same time increase the recoil : and if we increase the charge of powder, that of the shot remaining the same, we also increase the recoil, and disperse the shot much more than before. In every species of fire arms, large charges of powder are found to disperse the shot very much, whilst with smaller charges than are generally employed, it is thrown more steadily and closely. If the object, therefore, which we are about to fire at, be at too great a distance for the shot to take effect, and it happens that we cannot approach nearer to it, we ought not to increase the quantity of powder with a view to the shot being thereby thrown farther, as, by so doing, the increase of the *range* will be very trifling, whilst the dispersion of the shot will be greatly increased. The only expedient in this case, is, to employ shot of a larger size, the quantity of it, and of the powder, being kept the same as
has

has been already found best suited to the piece.

After what has been said in the preceding chapter, we cannot venture to determine what degree of closeness or dispersion in the *shot*, will entitle any piece to the name of a *good* or a *bad* one; but would observe, that if a fowling piece charged with an ounce of No. 2. patent shot, and a dram of powder, throws 60 grains into a sheet of paper 18 inches by 24, at the distance of 50 paces *, we may consider it as very capital, although these are only about *one-third* of the charge; and that the same piece continuing to be fired at the same mark and distance, will not, in the mean of four or five successive discharges, throw 36 grains into the paper; in short, that when due attention is paid to finding the suitable quantity of powder, and of shot, one piece will perform nearly as well as another.

Although gunsmiths in general have given up the idea that fowling pieces can be made

* We do not mean geometrical, but ordinary paces.

to throw their shot more closely by any alteration in the form of the barrel, from that in common use ; many of them are, nevertheless, persuaded, that the *force* and *quickness* of the discharge may, by certain contrivances, be considerably augmented. As in a sphere, the distance from the centre to the circumference is less than in any other solid of equal magnitude ; the passage of the flame through the grains of powder, placed in this form, is the quickest possible, and consequently the inflammation and explosion must be the most rapid and powerful. Accordingly a chamber of this form, which was larger than the caliber, so as to contain all the charge, was once employed in artillery ; but the struggle of the inflamed powder, in passing from the chamber into the caliber, produced so great a shock upon the piece and its carriage, that the spherical chamber was laid aside.

A chamber of this form is, for many reasons, still less suited to small arms than to pieces of ordnance. The Chevalier de Folard afterwards invented another kind of chamber

chamber for cannon and mortars; this was in the form of a truncated cone, its greater diameter being towards the breech. Its advantage over the former, consisted in its allowing the inflamed powder to escape more easily into the caliber; whereby there was less shock produced. *Monf. de Marolles* seems inclined to adopt this in small arms; but, like every other chamber whose diameter is greater than that of the caliber, it increases the recoil without augmenting the force of the discharge, and has therefore been long disused in artillery. Chambers of various other forms and dimensions, have been suggested and practised in small arms; but all of them less in diameter than the caliber, so that the inconvenience of an excessive recoil was thereby obviated.

These contrivances seem to be founded upon a principle adopted amongst engineers, that, in the construction of all fire arms, the greater the diameter of the base at which the powder is fired, the greater will be the inflammation, upon the degree of which

depends the impulsion given to the projectile. Some gunsmiths hollow out the breech-plug in a spherical form, and open the touch-hole into this by perforating the breech-plug about its middle ; but as the aperture out of this chamber into the barrel, is considerably less than the diameter of the chamber, the struggle of the powder in passing through it, will necessarily occasion more or less agitation and recoil in the piece when fired ; besides, as the chamber does not contain the whole of the powder, the good effects of the spherical form must be very inconsiderable. Other workmen, again, excavate the breech-plug in the form of a thimble, making the touch-hole pass through the side of the plug, and enter at the very bottom of the chamber. This form is not liable to the objections stated against the spherical chamber. The situation of the touch-hole is intended to prevent the recoil which is supposed to proceed from its entering the cavity at some distance from the extremity ; but as we have already treated
this

this sufficiently in the chapter upon the recoil of pieces, it is unnecessary to say any thing farther upon it here.

Somewhat similar to the last, but more complex, is a contrivance for which a patent has been obtained by a gunsmith of this city. It is termed a *false* breech, and resembles in its construction, the breech-part of the common screw-barrelled pistols. The plug-part of it, which screws into the barrel, has a thimble-like chamber in it, about an inch deep and half an inch wide. From the bottom of this there is an opening, about the eighth of an inch in length, and the same in diameter; this leads into what is termed the anti-chamber, which is a cavity formed by the touch-hole widening in a sugar-loaf form as it runs inwards: the anti-chamber is about a quarter of an inch in diameter, at its widest part. The advantages which are said to arise from this structure of the breech, are, “ that the shot are “ thrown in a more perfect direction and “ with greater velocity; that the barrel is “ much less subject to grow partially foul;

“ that guns upon this new principle, after
“ being fired twenty or thirty times, lose
“ very little of their force in comparison
“ with those of the old construction ;” and
lastly, “ that they are safer, and go off more
“ instantaneously.”

We do not doubt but the powder will generally take fire more quickly in these than in common barrels, owing to the touch-hole widening so much inwards, and the powder which lies in the anti-chamber never being bruised or rammed too hard, however considerable the force be that is employed ; an inconvenience that other barrels are liable to, especially in the hands of young sportsmen, or when they are charged in a hurry. The disadvantages inseparable from the construction of this patent breech, are, that the passage between the chamber and the anti-chamber, being very narrow, soon chokes up in the firing ; and that from the anti-chamber being considerably wider than this passage, the powder contained in it does not pass freely, when inflamed, into the caliber of the barrel, but exerts itself
against

against the touch-hole, so as to widen it very much.

Mr. Robins observes, that “the same quantity of powder acts *rather* more violently when it fills up a long cylinder, than when it fills up a shorter cylinder with a larger base ; at least there seems to be *some* advantage in lengthening the chamber until its length is near three times its diameter.” And the commentator on the works of Euler, whom we have had occasion to make mention of before, in an investigation of the question, whether the figure of the space which contains the powder may not contribute to a quicker or slower explosion, says, “that if it does, there can be no doubt that the figure which causes the quickest is the best ; for the quicker all the powder fires, the greater and of the longer continuance will the force which acts upon the ball be, and the quicker also will its motion be. And that the figure of the chamber contributes not a little to the quickness of firing is easy to be proved ; for, if a very long and

narrow tube be filled with powder, and fired at one end, the fire will not extend to the other end so soon as if the tube was shorter: thus it is easy to conceive, that if the chamber of a piece consists of such a long and narrow tube, the ball will be impelled from the piece with a much less degree of velocity, than if the chamber were shorter and wider, the charge of powder continuing the same. Hence also it is easy to conceive, that the powder fires the quicker the less distance the grains lie from each other. Now since of all figures under the same circumference, the globe contains the greatest space, so that the particles or grains of powder it contains will be nearer to each other than in any space of the same magnitude; therefore there can be no doubt but the same quantity of powder will fire sooner in a globular space, than in a space of any other form: the cavity behind the ball should therefore be as nearly as possible globular; for if it could be made exactly so, the velocity of the ball would receive a considerable
in-

increase from such a figure. The effect would be so much the greater if the powder could be fired in the middle, since in this case the fire would extend sooner to all the extremities. But the more the force of the powder may be increased in this manner, the barrel ought to be stronger in the part where its greatest force is exerted." Whether or not the contrivances we have been just now describing, were founded upon any of the hints thrown out in these opinions (if we suppose the gunsmiths to be so deeply read), we cannot pretend to say; but we can safely assert, that no one of the gunsmiths, with whom we conversed on the peculiar construction of the breech, made and recommended by himself, could give any satisfactory or scientific account of the reasons and principles on which he formed it. Upon any thing relating to fire arms, the authority of Mr. Robins is deservedly placed in the first rank; but we do not think that what he has here said, promises much advantage from lengthening the cylinder of the

the powder by means of a chamber; and the little that can be gained by it is fully counterbalanced by the disadvantages we have mentioned.

CHAP.

C H A P. X.

Of Rifle Barrels.

IT has been found that the flight of balls both from cannon and small arms is liable to very considerable variations; and that the piece, notwithstanding it was firmly fixed, and fired with the same weight of powder, sometimes threw the ball to the right, sometimes to the left, sometimes above, and at other times below the mark. It has also been observed, that the degree of deflection increases in much greater proportion than the distance of the object fired at: thus, at double the distance, the deflection of the ball from the line on which the piece is pointed, is considerably more than double, and at treble the distance, more than treble what it was in the first. Mr. Robins secured a musquet barrel upon a block of wood,

wood, and firing it with a ball, at a board of a foot square, 60 yards distant, found that it missed the board only once in sixteen successive discharges; yet when fired with a smaller charge, at the distance of 760 yards, it sometimes threw the ball 100 yards to the right, and at other times 100 to the left of the line it was pointed in. The direction upwards and downwards also, was found equally uncertain, the ball sometimes bending so much downwards as to fall 200 yards short of its range at other times. Yet the nicest examination could not discover that the barrel had started in the least from the position in which it was first fixed.

It is impossible to fit a ball so accurately to any plain piece, but that it will rub more against one side of the barrel than another, in its passage through it. Whatever side, therefore, it rubs against on its quitting the muzzle, it will acquire a whirling motion, towards that side, and will be found to bend the line of its flight in the same direction, whether it be to the right or the left, upwards, downwards, or obliquely. This
deflection

deflection from a straight line, arises from the resistance which the air gives to the flight of the bullet, it being greatest on that side where the whirling motion conspires with the progressive one, and least on that side where it is opposed to it: thus, if the ball, in its passage out, rubs against the *left* side of the barrel, it will whirl towards that side; and as the *right* side of the ball will therefore turn up against the air during its flight, the resistance of the air will become greatest on the *right* side, and the ball be forced away to the *left*, which was the direction it whirled in. If the axis, round which the ball whirls, preserved its position during the whole of the flight, the deflection would be in the same direction from the one end of the track to the other. But from accidents that are unavoidable, the axis of the whirl frequently changes its position several times during the flight; so that the ball, instead of bending its course uniformly, in the same direction, often describes a track that is variously contorted. So great, however, is the tendency of the ball

ball to deflect itself towards the side it rubs against, that although, when fired out of a barrel that is bent towards the *left* hand, it will be thrown from the piece in the direction of the bend, yet as the ball in this case will be forced to rub against the *right* side of the muzzle, and thus turn its left side up against the air; so it will be found to alter its course during the flight, and bend away towards the right hand, so as to fall a considerable way to the right of the line in which the piece was pointed.

From what has been said, it will readily appear, that these variations will be more frequent and considerable when the ball runs very loose in the piece; or when, from any roughness upon its surface, or on the inside of the barrel, a considerable degree of friction takes place between them. With a view to prevent friction, it has been proposed to grease the ball; but this will be of little service. All that can be done in a plain barrel, is, to have the balls cast very solid and true, and afterwards milled in the same manner as is now practised upon shot:
the

the barrel also should be very smooth on the inside, and the ball fit it very accurately, so as to leave scarcely any windage. And yet with the help of all these it will still be very difficult to prevent it altogether, for gravity will constantly act, and friction on the under side will naturally be occasioned by the weight of the ball.

From considering the causes of this aberration in the flight of bullets, it will be pretty evident, that the only means of correcting it is by preventing the ball from rubbing more against one side of the barrel than another in passing through it; and by giving to the bullet a motion, which will counteract every accidental one, and preserve its direction by making the resistance of the air upon its fore part continue the same in every part of the flight. The contrivance for this purpose is termed *rifling*, and consists in forming upon the inside of barrels, a number of furrows either in a straight or spiral direction; into these the ball is moulded, and any rolling motion along the sides of the barrel in its passage out, thereby prevented. Barrels of
this

this construction have been in use upon the continent since the middle of the 16th century, but were little known, and still less employed, in England, until within these last 50 years. The *spiral* rifled barrels, however, have entirely superseded the *straight* rifled ones, because, although the latter prevented the rolling motion of the ball that takes place in a plain barrel, yet they do not communicate any other motion, that could serve to correct the variations that may occur during the flight.

The furrows, or channels, which are termed the *rifles*, vary in number according to the fancy of the workman, or that of the purchaser, but are never less than six, or more than twelve in a common-sized piece*. Their depth is equally subject to variation; but the breadth of the furrows and of the threads is generally the same. In some pieces, the spirals make a *half* turn, in others *three-fourths*, and in

* In the Memoirs of the Academy of Sciences at Petersburg, ann. 1728, there is a curious tract on this subject, entitled, *De sulcis cochleatis ad datam distantiam tubis sclopetorum rectè inducendis.*

officers, again, an *entire* revolution in the length of the barrel: an entire revolution, however, is the most common; though, from the great difference in the length of rifle barrels, there should be some standard assigned for the obliquity of the spiral. There is, without doubt, a certain obliquity of the spirals which would communicate a rotary motion to the ball, sufficient to correct any aberration in its flight; and this might be determined by comparing the effects of a number of pieces, that differed only in the obliquity of the rifles. Barrels intended to be rifled, are previously bored and smoothed within, in the manner already described: they are, however, forged as much thicker than plain barrels as the depth of the rifles; for although the threads of the spiral add to the *weight* of the barrel, they do not increase its strength in the least, with regard to the force exerted upon it by the powder. As the manner in which the rifles are formed, could not be well understood without a plate, we shall not attempt to give any description of it.

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These

These pieces are charged in various ways. In general, the ball, which is somewhat larger than the caliber before it was rifled, is driven down to the powder, by means of an iron rammer, struck with a mallet, whereby that zone of the ball which is in contact with the sides of the barrel, becomes indented all round, and is moulded to the form of the rifles. When the piece is fired, the projections of the ball which fill the rifles, being obliged to follow the sweep of the spiral, the ball thereby acquires a rotary motion upon an axis that corresponds with the line of its direction; so that the side of the bullet which lay foremost in the barrel, continues foremost during the whole of the flight. By this means the resistance of the air is opposed directly to the bullet's progress, and not exerted more against one part than another of that side which moves foremost; and accordingly the bullet preserves the line of its direction with very great steadiness.

It appears that neither the inventors of spiral rifle barrels, nor the persons who first used them, were at all acquainted with the
prin-

principles upon which they produced their effects. Some were of opinion, that, owing to the ball not passing out so quickly as out of a plain barrel, the powder was more completely inflamed, and thereby exerted a greater force upon it. Others, and these by far the greater number, thought that the ball, by combining the rotary with the progressive motion, did, as it were, bore the air; thereby flying much farther, and penetrating solid bodies to a greater depth, than when discharged from a plain barrel. But Robins asserts, that as the bullet meets with a greater resistance in its passage through a rifled barrel, than through a plain one; so neither its velocity, nor the distance to which it is thrown, is so great when fired from the former, as when fired from the latter: and this difference will be very remarkable if the rifles be deep, and the ball fills them up completely; the friction, in that case, bearing a considerable proportion to the force of the powder. For the same reason, he says that barrels which are newly rifled, and, consequently, somewhat rough

within, do not throw their balls so far as they will be found to do after being used for some time, and thereby rendered smother; and that the mistake of those who supposed that rifle barrels threw their ball to a greater distance than plain barrels did, arose from their finding that, with the former, they could hit a mark at three or four times the distance they could do with a plain barrel*.

Besides the method of loading a rifle barrel, by driving down the ball with an iron rammer, there are several others which we shall mention. In Germany they sometimes charge them in the following manner: a piece of thin leather or fustian is cut of a circular shape, and so large as to cover a little more than one half of the ball; this

* But we have been informed by a gunsmith of eminence, that rifle barrels do throw a ball to a greater distance than plain ones; and indeed, from observations of our own lately made, we have reason to think this information to be the fact. This person further assured us, that rifle pieces are not suffered to go out of the hands of the maker until the threads were perfectly polished and smooth. Indeed it seems to be obvious, that the threads of the rifle must be made in a very coarse manner, to admit of improvement by repeated firing.

piece is then greased on one side, and being placed over the muzzle, the ball is laid upon it, and both thrust down together ; by this means the leather or fustian enters into the rifles, and the bullet being firmly embraced by it, acquires the proper rotary motion in its passage through the barrel. If this method be equally effectual, it is certainly much more easy and expeditious than that already described. Some of the old pieces of this construction, were charged by taking out the breech every time ; and we are informed, that the pieces used by the Hessian yagers, are charged in the same manner as the common screw-barrel pistols. By far the most expeditious way of charging rifled pieces, however, is, by means of an ingenious contrivance which now generally goes under the name of Ferguson's rifle-barrel, from its having been employed by Major Ferguson's corps of rifle-men during the last American war. In these pieces, there is an opening on the upper part of the barrel, and close to the breech, which is large enough to admit the ball. This opening is

filled by a rising screw which passes up from the lower side of the barrel, and has its threads cut with so little obliquity, that when screwed up close, a half-turn sinks the top of it down to a level with the lower side of the caliber. The ball being put into the opening above, runs forward a little way; the powder is then poured in so as to fill up the remainder of the cavity, and a half-round turn brings the screw up again, cuts off any superfluous powder, and closes up the opening through which the ball and powder were put. The *chamber* where the charge is lodged, is without rifles, and somewhat wider than the rest of the bore, so as to admit a ball that will not pass out of the barrel without taking on the figure of the rifles, and acquiring the rotary motion when discharged. The only advantage of this contrivance, is, the ease and expedition with which the piece can be charged, and which are even much greater than in a plain barrel. For when the ball is forced through the rifles by the effort of the powder, the friction must be considerably

derably more than when it is moulded to them in the ramming down. It appears, however, that in whatever way the piece is charged, this friction might be much diminished, by making the channels or furrows very broad in proportion to the breadth of the threads, and, instead of leaving the latter flat on the top, to have them terminating in a sharp edge, whereby they would cut easily into the ball. This would also serve to lessen the additional quantity of metal in the barrel, which, as the rifles are now formed, bears a very considerable proportion to the weight of the whole piece. The depth of the rifles, likewise, need not be great, as a very slight hold of the ball is sufficient to communicate the desired motion: deep rifles are particularly detrimental when the piece is charged at the breech; for if the ball be large enough to fill them up entirely, the resistance, and, consequently, the recoil, will be very great; and if it does not fill the rifles, there will be so much windage,

that a considerable portion of the flame will escape past it, and the force of the discharge be thereby greatly lessened.

To render rifle-barrels as complete as possible, we should endeavour, by every means in our power, to diminish the friction between the bullet and the sides of the barrel. We have already mentioned some alterations which we think would conduce to this. The turns of the spiral being exactly parallel to each other, and both the threads and the furrows being made perfectly smooth, are circumstances absolutely essential to perfection; as thereby the bullet, when once put in motion, will pass through the barrel with very little friction. The most accurate method of ascertaining this, is, by pouring melted lead into the barrel so as to form a cylinder of two or three inches in length, and which is exactly fitted to one portion of the caliber: if this cylinder, when moved a little, passes without stop or difficulty from one end of the barrel to the other, by being pushed gently,

gently, the rifling may be pronounced very exact. The same thing may be tried with a plug or ball of lead, driven into one end of the barrel so as to fill the rifles, and pushed forward with the ramrod.

From the imperfect manner in which any instrument works in a spiral direction within the barrel, the furrows are generally left very rough; and hence rifled pieces are found to throw their ball to a greater distance, though with equal accuracy, after being used for some time, and thereby having the bottom of the furrows, and edges of the threads, worn smooth. We think that these might be rendered smooth at first, by means of a plug of lead or pewter made to fit the rifles, being fixed to an iron rod, and wrought backwards and forwards in the barrel, with fine emery and oil: or the leaden plug might be employed as a pattern to form one of brass or steel by, for the same purpose.

As the pieces which are charged at the
breech,

breech, are considerably dearer than the others, and, excepting the expedition with which they can be charged, are really inferior to those charged at the muzzle; we are of opinion, that the latter might, by a very simple means, be rendered equally serviceable with the former. This is nothing more than having the balls cast with projections that answer to the rifles; which may be done with great ease and accuracy by making corresponding hollows round a zone of the bullet-mould: by this the ball may be fitted so accurately to the rifles, as to leave scarcely any windage; whilst the friction will be less than it is either when the ball is put in at the breech, or forced in by the muzzle.

The only other improvement which this matter seems to admit of, is, that of making the balls in the form of an egg; as these, from having their centre of gravity nearer to the great end than to the small one, will, when fired with the larger end foremost, preserve their course much more

steadily than those of a spherical figure. Bullets of this shape may be used either in plain or in rifled barrels*.

In treating of the causes of aberration in the flight of balls, we have supposed the air to be perfectly still; it being evident, that the force of the wind will affect balls considerably, whether they are fired from a plain, or from a rifled barrel; but, for the reasons already given, will affect the former in a much greater degree than the latter.

Pieces intended for shooting with ball, whether they be plain or rifled, ought to be of much more equal thickness from the breech to the muzzle, than those that are intended for shot only. In every barrel, there is an undulating vibration communicated to the metal by the explosion. This is most remarkable in a *thin* barrel, and

* Our experiments, however, lately made to ascertain this fact, have turned out contrary to our expectation; for we found that the oblong balls did not retain their rectilinear direction, but on the contrary whirled round.

when

when the charge is great; and may be rendered very evident by the following easy experiment. Take a piece of fine steel or iron wire, that is tempered so as not to stretch readily; pass it once round the thin part of the barrel, and twist it tight. The piece being then charged and fired, the wire will be found burst asunder, or considerably untwisted. It is evident, that such a degree of vibration in the barrel, must have an effect upon the ball in its passage through it; and that the only means of preventing it, is, by having an additional quantity of metal in the barrel, and especially in the fore part of it. The same circumstance certainly obtains, though in a much less degree, in fowling pieces; and on this account, as well as on that of the recoil, a barrel which is strong enough to withstand any charge that is required, may yet have too small a quantity of metal in it.

Having now fully explained the principles upon which rifle barrels produce their

their effects, our readers will be prepared to consider how far the *straight* rifling can be useful when employed for shot. These pieces are said to be very common in Germany, and are used by a few persons in this country; though we understand that the greater number even of these few are now less partial to them than they were at first. If the divergency of shot arises from the same cause as that of ball, viz. from acquiring a whirling motion to one side or other by rubbing against the sides of the piece, it is evident that rifling the barrel can have no tendency to prevent this. For let it be granted, that the channels or flutings within are semicircular, and that the shot is exactly adapted to these (two circumstances said to be necessary to the perfection of these pieces), it cannot be imagined that the grains will acquire less of the rolling motion in passing along these flutings, than in passing along the sides of a plain barrel; on the contrary, it will necessarily be greater, as the points of contact are considerably more numerous.

It

It may not be improper to mention, that the same wonderful powers and effects were ascribed to this construction of the barrel, as invariably are to all the improvements—or rather alterations (however trivial)—either made or adopted by the gunsmiths in this age of whim; the assertion always is the same, that the piece is thereby not only to carry its shot much closer, but to shoot much farther. To the honour of the discerning part of the sportsmen of the present age, those novelties and fancied improvements have but their day.

C H A P.

C H A P. XI.

Of the Stock, Lock, &c.

UPON the other parts of the fowling piece, there is little required to be said, as they are varied according to the fancy of the workman, or the whim of the purchaser, without any material advantage or detriment to the piece.

The wood which is most commonly employed for the stock, and which appears the best for the purpose, is walnut ; and the only choice in this, is, that the grain be even and close, and as free as possible from knots and burrs, which, though they may add to the beauty of the stock, seldom fail to take away from its strength, unless they are confined entirely to the butt part. As to the curvature, no particular degree can be assigned as a standard ;
different

different persons requiring different degrees, according to the length of their neck, and to the manner in which they hold their head whilst taking aim. This, therefore, as well as the *length* of the butt, which depends partly upon the circumstances just mentioned, but chiefly upon the length of the arms, can be determined with great accuracy by the gunsmith, from observing the manner in which the shooter presents his piece and takes his aim.

With regard to the locks, we have nothing material to offer; the genius and industry of the English workmen having already brought them to such a degree of elegance and perfection, that we have scarcely any thing farther to hope for, or require. The real improvements are not confined to any particular maker; and though the minutiae peculiar to each, may determine the purchaser in his preference, no person need fear much disappointment in the essential qualities of a lock, provided he goes to the price of a good one.

It

It is of much more consequence to the excellence of a lock, that the springs be proportioned to each other, than that they should all be made very strong. A moderate degree of force is sufficient to produce the required effect, and whatever exceeds this, proves detrimental, by rendering the trigger difficult to draw, or producing such a stroke as breaks the flints, or throws the piece from the direction in which it was pointed. If the main-spring be very strong, and the hammer-spring weak, the cock is often broken for want of sufficient resistance to its stroke, until it is stopped all at once by the cheek of the lock-plate. Whilst, on the other hand, if the hammer-spring be stiff, and the main-spring weak, the cock has not sufficient force to drive back the hammer. And, in both cases, the collision between the flint and steel is too slight to produce the necessary fire. The face of the hammer, also, may be too hard or too soft. The former is known by the flint making scarcely any impression upon it, and the

L sparks

sparks being few and very small. The latter is known by the flint cutting deep into the hammer at every stroke, whilst the sparks are also few in number, and of a dull red colour. When the strength of the springs, and the temper of the hammer, are in their due degree, the sparks are numerous, brilliant, and accompanied with a considerable whizzing noise.

To explain these differences it is necessary to observe, that the sparks produced by the collision of flint and steel are particles of the metal driven off in a strongly-heated state, and which falling among the powder inflame it instantly. By snapping a gun or pistol over a sheet of white paper, we may collect these sparks, and, by submitting them to a microscope, demonstrate the truth of this. If the sparks are very brilliant, and accompanied with a whizzing noise, we shall find the particles collected on the paper, to be little globules of steel, which were not only melted, but have actually undergone a considerable degree of vitrification from the intensity

of the heat excited by the collision, their surface exactly resembling the slag thrown out from an iron foundery. When the face of the hammer is too hard, the particles which the flint strikes off, are so small, that they are cooled before they fall into the pan; and when the hammer is too soft, the particles driven off are so large as not to be sufficiently heated to fire the powder.

We think the conical form of the touch-hole a real improvement; but do not approve of its widening so much as it does in the patent breech, as the force of the fuse against the opening into the pan, is greatly increased by it.

Gold pans are of very little advantage; for as the iron must be softened before they can be applied, it is very liable to rust, and thus destroy its connection with the gold; the tin, also, by means of which the gold lining is fixed, is frequently melted by the fire of the fuse being directed upon the bottom of the pan, and the gold thereby detached from its hold; this will happen more readily when the touch-hole is placed

very low, and when, from its form or width, the fire of the fuse is considerable, A great improvement, however, has lately been made in the manner of putting in the gold pans; they are now "DOVETAILED" in, before the lock-plate is hardened, by which means they seldom or ever "BLOW" out; and it is now found that they will stand better than any other species of pan, provided that the lock is eased from the touch-hole, or taken off when the barrel is taken out of the stock. Still we are of opinion that the steel pan will be found, with common care in cleaning it, to last as long, and to answer every purpose as well, as when lined with gold.

E S S A Y
ON
S H O O T I N G.

PART II.

Come then, ye hardy youths, who wish to save
By generous labour powers that nature gave ;
Glad on the upland brow, or echoing vale,
To drink new vigour from the morning gale ;—
Come ! and the muse shall shew you how to foil
By sports of skill the tedious hours of toil ;
The healthful lessons of the field impart,
And careful teach the rudiments of art.

SHOOTING, a *Poem*, by H. I. PYE, Po. Laur.

C H A P. XII.

Remarks on the Properties and Action of Gunpowder, and Instructions for the Choice of Gunpowder, Shot, Wadding, &c.

ALTHOUGH we must admit, that dexterity in shooting is the main point in the success of the chase; that practice alone acquires it; and, that it is possessed by sportsmen in different degrees, according to the aptitude which nature has bestowed on them for the amusement; still, it is no less true, that, in order to obtain complete success, this dexterity should be assisted by several necessary means, and by certain precautions and attentions, which ought on no account to be neglected. These we shall endeavour to lay down, and therefore proceed to give some instructions on the articles of *powder*, *shot*, and *wadding*, the principal agents of the sport.

P O W D E R.

THE various kinds of powder used in England are so well known, that they need not be enumerated here. Our experience formerly induced us to recommend Hervey's battle powder, as being, at that time, superior to every other we had met with. The candour and justice, however, that are due to the merits of individuals, and to those improvements that are from time to time made in the arts, combined with our individual wish to give every kind of useful information to the sportsman, compel us to say, that we can now again, and with the greatest confidence that can be supposed to result, as well from subsequent experience of our own, as from the corroborating testimony and approbation of others, recommend the Dartford powder of Mess. Pigou and Andrews, for being, not only stronger, but the cleanest in burning and the quickest in firing, of any other at this time manufactured in the kingdom ; and we also ver-
ture

ture to give it as our opinion, that the manufacturers of this powder seem to have attained, as nearly as any purpose can require, that accuracy of granulation, and of the proportions and qualities of all the ingredients, which most readily produces the destruction of all the composition, and yields the greatest possible quantity of the permanent elastic fluid in a given time, which properties alone can constitute powder of the best quality.

The excellence of this article as to its properties, and the relative condition in which it is at the time of using it, with respect to dryness, dampness, or age, are in themselves circumstances so obviously important to the sportsman, that we have often been astonished at the almost total neglect which attends this part of the shooting science: but he may henceforward be assured, that, without the utmost circumspection and care herein, his high-priced fowling piece will but little avail him; mortification and disgust will generally ensue, and the gunsmith too frequently be blamed for the
fault

fault which the sportsman alone has created by his own neglect.

Let us endeavour to render the defect in point of attention to this most principal article of the sportsman's panoply, less prevalent in future.

To this end, a plain and concise description of the composition and properties of gunpowder will not, we hope, be incompatible with the present work.

The *making* of powder requires a considerable knowledge of chemistry; and to enquire into the amazing force of gunpowder, we must take natural philosophy to our assistance. To treat, therefore, of the force of gunpowder in its full extent, requires so much knowledge in the higher branches of mathematics and mechanics, that we may fairly ascribe to this reason, the few treatises that have been written on the subject.

As the most learned work, however, that we have yet met with on this topic, we may safely mention the Treatise of Monf. d'Antoni, who is the chief director of the Royal Military Academy at Turin. The following obser-

observations are extracted from the elegant translation of the above work, by Captain Thompson of the Royal Artillery ; and we are induced to do this from the persuasion, that they comprehend every thing that the sportsman has occasion to know for the purpose of inculcating the attention and knowledge already so strongly recommended ; and to this translation we beg to refer such of our readers as wish for the most complete and extensive information on the properties of powder, and the science of gunnery in general.

Gunpowder is composed of very light charcoal, sulphur, and well refined saltpetre. The powder used by sportsmen in shooting game, is generally composed of six parts of saltpetre, one of charcoal, and one of sulphur ; but these proportions, as well as the introduction of other ingredients, and the sizes of the grains, are undoubtedly varied by the different manufacturers in the composition of the powders of the same denomination, and are always kept profoundly secret.

These

These materials are put into a wooden trough, where they are ground together, to render the contact of the nitrous and combustible particles intimate and equal throughout the whole mass. The mixture is occasionally sprinkled with water, to form an amalgam, which is afterwards granulated, and to prevent the finer particles of the sulphur and the charcoal from flying off, which would necessarily alter the proportion of the composition. The powder makers employ more or less time in the operation of grinding, in proportion to the quantity and quality of the saltpetre. When they conceive that the ingredients are properly mixed together, they form from the paste those little grains which, being dried, obtain the name of gunpowder. The coal used in the making of this sort of powder is either of willow, hazel, or dogwood, well charred in the usual manner, and reduced to a fine powder.

In the first years that succeeded to the discovery of gunpowder in Europe, the proportion of the constituent parts, and the
size

size of the grains, varied very much, which gave rise to the several denominations it has obtained. At the beginning of this century these proportions and sizes were almost every where reduced to three; and at present, throughout all Europe, only one kind is used for military purposes.

The properties and effects of gunpowder can only be ascertained by the means of fire: it is necessary, therefore, in the first place, to examine the nature of fire itself, according to the doctrine of those philosophers, who, by the closest investigation of its effects, have endeavoured to explore its principles and causes.

The celebrated Herman Boerhaave, whose opinions have been adopted by the most eminent chemists, could only, after a long series of experiments, discover a few of the properties from which fire has derived its several denominations, according to the various modifications under which it presents itself to our senses.

Pure fire is called fire, solar matter, light and heat: under this idea it is conceived to

be a substance essentially fluid, composed of particles very subtle, and continually agitated, though not always in the same degree. The learned Beccari has proved that it exists in all places, and in almost all bodies, without being able to decide whether it be a constituent and essential principle. A gentle friction of a globe of glass in the electric machine, shews that every thing partakes of it; and two hard bodies rubbed violently together gradually grow warm, and at length emit sparks and flame according to their several qualities.

Fire which seems to pass from a fluid to a solid state, and become a part of the body, as the inflammation of some bodies evidently shews, is called combustible matter, sulphur, the food of fire, and phlogiston.

One of the distinct characters of fire, considered as solar matter, light, &c. is to easily penetrate bodies by insinuating itself into them equally, and expanding them so as to cause a disjunction of the component parts when introduced in quantity. But the facility with which fire effects this is dif-

different, according to the qualities of the bodies it enters; there are even some which, far from being dilated by the action of fire, are contracted, as wood, animal bodies, &c.

Another character of fire is, to render substances luminous, either by means of the flame which breaks from them, or by their becoming red. Fire considered as combustible matter, sulphur, phlogiston, &c. causes no change in the body in which it resides, nor does it communicate to it either light or heat, unless it pass from a quiescent state to ignited motion, or inflammation.

The different effects of the first species of fire may be considered under three heads:

In a determined space.

As actually existing in a body. And

With regard to the manner and law in which it enters and expands bodies of different natures.

Considering fire in a determined space, we find that, as its quantity and velocity may vary, so also in the same proportion will its activity and efficacy be different; as may be observed in burning glasses, reflecting telescopes,

telescopes, &c. The activity and efficacy of fire can only be ascertained by the expansion of bodies, and the disjunction of their parts : but hitherto the method of measuring exactly not only the quantity and velocity of fire separately, but even its absolute effects on bodies are unknown. The point to which a body entirely deprived of fire can be condensed, is equally undetermined with the first instant of its expansion. The condensation of mercury, produced by a certain quantity of sal-ammoniac and snow mixed together, is, in the construction of thermometers, the lowest point that we know ; while that, from experiments made in more northern climates, it is clear that mercury can be much more condensed. In the construction of pyrometers, the point of the greatest condensation depends on the variable temperature of the atmosphere. Thus these two instruments serve only to shew, by their graduation, the difference of expansion, according to the degree of fire that they contain or are penetrated with.

The activity of fire considered as actually
existing

existing in a body, depends, not only on the quantity and velocity of the ignited matter, but also on the mass of the body in which it exists. On attempting to reduce two fluids of unequal density to the same temperature, the most dense requires the greatest degree of heat: thus, when the activity and degree of fire which the two bodies contain, are proportional to their respective masses, they are equally hot. On touching two bodies of unequal density, reduced to the same temperature, the most dense appears the hottest; because the hand being in contact with a greater number of particles in the denser body, the sensation excited is proportionally stronger.

The manner and law under which fire penetrates bodies, is modified by the degree of its activity, the time of application, and the superficies, quality, and mass, of the surrounding bodies; for, should any one of these circumstances vary, a different modification will result. Thus, put into the same fire two pieces of iron of the same quality, but of different sizes, the smaller piece will

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become

become hot much sooner than the larger one; and if the surface of the larger piece be increased by flattening it with a hammer, it will become hot in less time. This diversity of effects may be equally remarked on comparing a piece of iron with a stone or any other body, put into the same fire. These observations on the facility with which fire insinuates itself into bodies, are equally applicable to the facility with which it quits them, and diverges from its focus: for when the quantity of fire in any body is greater than in the atmosphere or other surrounding bodies, it quits that body, and removes from it, spreading itself equally on all sides; its activity diminishes in proportion to its distance from the body which it quitted, and its extension depends on its excess over the external fire, on the time of application, the superficies, quality, and mass, of the surrounding bodies.

Having thus examined the various circumstances that tend to modify the effects of fire, let us now consider these modifications with respect to the ignition and destruc-

tion of combustible bodies. Whether the ignited motion excited in a combustible body appears under the form of flame, or burning coal, it is always produced in two manners ; either by applying to the combustible body a quantity of external fire, or by increasing the motion of the fire that exists in it.

From the facility with which combustible bodies take fire, they may be ranged in two classes. In the first may be placed spirits of wine rectified, sulphur, &c. in which, by applying fire to any one part, it is communicated to the whole mass, so as to produce a total destruction. In the second class may be ranked coal, the greater part of vegetables, &c. in which fire can be propagated only by a continued application, by increasing the motion in the ignited parts, or by placing the bodies in such a manner, that the fire, in escaping from the burning particles, may meet almost instantaneously those not yet ignited.

The degree of ignition varies according to the different qualities of the bodies themselves ; for a greater degree of fire is requi-

sive in proportion to the rarefaction of the surrounding air, or to the difficulty of removing from the ignited body smoke or other substances, which do not serve as food to fire. In both these cases it is necessary either continually to apply fresh fire, or to increase the motion of that which already exists in the body.

From these premises it may be inferred, that fire admits of infinite diversity in its effects, arising not only from the time of application, the superficies, quality, and mass of the bodies to which it is applied, and which surround it, but even from the modifications that ensue from the quantity and velocity of the ignited matter. Wherefore the force of gunpowder fired in musquets, cannon, mortars, mines, &c. being in proportion to its inflammation, its effects must inevitably be modified by the quantity and the proportion of the ingredients, the temperature of the atmosphere, and other circumstances that will be hereafter pointed out. And since it is not in our power to determine every point that affects its inflammation.

flammation and total consumption, we cannot be always certain of producing the same effects with the same quantity of powder fired from the same piece of ordnance.

Sulphur is a substance composed of vitriolic acid and a combustible matter. It is ranked in the class of minerals, because it is extracted from the bowels of the earth. When exposed to a moderate degree of heat, it liquefies, and sublimes in little tufts called flowers of sulphur: thus it is purified from heterogeneous substances by sublimation.

The property of sulphur is to take fire, inflame, and be entirely consumed, when exposed in the open air to a stronger fire than that which will liquefy it. It is made use of in the composition of gunpowder, because the ignited motion is easily propagated in it.

The facility with which sulphur takes fire and burns, depends on the rarefaction of the surrounding air. To burn it in an exhausted receiver, it requires a continued application of a much greater degree of heat than would inflame it in the open air:

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the receiver should also be of a size proportioned to the quantity of sulphur, lest the condensation of the smoke prevent its total consumption. The only method of decomposing sulphur, is by burning; which destroys the combustible matter, and the vitriolic acid exhales in vapour.

Charcoal used in the composition of gunpowder, is defined to be a body composed of a combustible matter, and of the dense earthy particles contained in vegetables. In making charcoal, the vegetables are burned in such a manner, that they do not inflame; and then the combustible matter unites itself intimately with the most dense earthy particles. Charcoal can only be decomposed by fire, which, at the beginning of the ignition, separates the combustible matter from the earthy particles, which are then termed cinders.

When charcoal is exposed in the open air to a sufficient degree of fire, its property is to burn and be consumed. It sometimes emits a little blue flame; but more frequently sparkles, and becomes red without emitting
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any flame. If in this state it be agitated by the wind, it appears of a more lively and brilliant red in proportion to the force of the wind, and is sooner reduced to cinders. From this property it enters into the composition of gunpowder.

Generally speaking, charcoal appears red only when a greater degree of fire is applied to it than will burn sulphur; the propagation of the ignited motion, and its total consumption, are effected more slowly than in sulphur. These effects differ according to the quality of the charcoal: that which is the lightest, or which contains least of the dense earthy particles, takes fire and is consumed the quickest.

The more the air is rarefied the more difficultly charcoal burns, and the greater degree of fire is requisite to keep it red-hot.

Saltpetre is formed from a combination of the nitrous acid with a fixed alkali. It is extracted principally from animal and vegetable substances, found in a putrescent state, mixed with stones, earths, and plaisters, and is separated from them by boiling them

in a water impregnated with a fixed alkali. The salt crySTALLIZES in long filaments, lying one upon another. This is the only method of purifying it; and must be repeated two or three times, according to the quantity of the heterogeneous matters. When by this process the saltpetre has been well purified, it has always the same properties, from whatsoever substances it may have been extracted.

Its properties are, to dissolve in water, more fully in boiling than in cold water; and to liquefy, by a greater degree of heat than is required to liquefy sulphur. If the heat be increased while the saltpetre is in fusion, it sublimes in visible particles; which, collecting together on the upper part of the vessel, are called flowers of nitre. To separate the acid from the alkali, without putting the saltpetre in contact with a combustible body, it is necessary to expose it a long time to a very strong fire; and even then the decomposition is brought about very slowly.

If a combustible body containing a sufficient

ficient degree of heat, touch saltpetre, a very fierce flame is excited at the point of contact, accompanied with detonation, and a wind which increases the activity of the fire. In this operation the acid is separated from the alkali, and dissipated. The combustible body is instantly consumed, and the alkaline residuum is termed decomposed, or fixed nitre.

This decomposition of saltpetre takes place equally in the open air and in vacuo; provided that, in vacuo, the action of the fire be sufficient to keep the combustible body in a state of ignition. Saltpetre may be decomposed by fire in two ways: by coming in contact with an ignited combustible body when in a solid state; or by communicating, when in fusion, the ignited motion to a combustible body in contact with it.

In the first case, by applying burning charcoal, the decomposition begins and continues till the saltpetre or the charcoal be entirely consumed. To effect the destruction of both at the same time, the quantity of charcoal must be proportioned to the
quantity

quantity of saltpetre. The better the substances are mixed together, the more immediate will be the contact between the several parts, and the sooner will both be consumed.

Burning sulphur not being able of itself to decompose saltpetre, charcoal is added to it. Now charcoal of every kind burns when exposed a sufficient time to the action of burning sulphur; yet this takes place sooner or later in proportion to the density of the charcoal, or to the quantity of dense earthy particles; wherefore, that the fire produced from the sulphur may be sufficient to burn all the charcoal, the quantity of each must be exactly proportioned, and attention paid, at the same time, to the quality of the charcoal.

When this proportion is determined, a quantity of saltpetre added, and the three substances well ground together, in order to render the inflammation more instantaneous, even then the effects vary; for if the saltpetre be in too great a quantity, the combustible particles being too far separated, the fire applied to one part will not be able to spread

spread to the others ; or the combustible particles, being in too small a quantity, will be consumed long before the saltpetre. If, on the contrary, the saltpetre be in too small a quantity, it will be consumed before the other two ingredients ; wherefore, that the destruction of the three may begin and end at the same time, they must be mixed in a just proportion. As soon as the saltpetre begins to be decomposed, the wind generated from it renders the heat of the charcoal more intense, increases the activity of the fire, and accelerates the total destruction of the whole.

This decomposition of saltpetre, by the application of charcoal and sulphur, is similar to the process that takes place when powder is burned in the open air, or in fire arms.

There seems to be nothing in the fabric of gunpowder, that can alter any of the properties of the constituent parts, taken either individually or collectively. The necessity of having a combustible body capable of producing the total and instantaneous decomposition of the nitre, makes sulphur and charcoal requisite ingredients :
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fulphur, because it easily takes fire and propagates the inflammation, though the heat it produces is not sufficient to decompose the nitre: charcoal, because its inflammation, as well as the propagation of fire into all its parts, being slower, it acquires, when it becomes red-hot, a stronger degree of heat than the sulphur, and is therefore more capable of producing the entire decomposition of the nitre. Therefore, from their combination with a proper proportion of nitre, the most instantaneous explosion may be expected; but if the quantity of nitre be too great, the fire, communicating to the combustible particles with so much the more difficulty as the excess is the greater, may produce no effects. If to a composition of fourteen parts of saltpetre; one of sulphur, and one of charcoal, a burning coal be applied, those parts only of the mixture in contact with the coal will burn, the flame not being able to communicate itself to the other parts. If, on the contrary, the nitre be in too small a quantity, on applying fire to one part, the flame which breaks out at its decomposition is too weak to spread itself
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to the others, owing to the great distance of the nitrous particles : the destruction of the whole, therefore, requires a much longer time ; and the quantity of permanent elastic fluid, on which depends the greatest force of the powder, is less ; as may be proved by burning a mixture of equal parts of sulphur, charcoal, and saltpetre.

We will now proceed to prove, that fired powder preserves constantly the properties remarked in the combination of its ingredients, modified nevertheless by the exactness of the mixture, the size of the grains, and other circumstances that will be pointed out. All degrees of heat are not sufficient to fire powder ; for if it be only *sufficient to* inflame sulphur, the effects before mentioned will result, as may be proved by throwing several grains of powder near hot coals. The burning of the grains contiguous to the coals will be so instantaneous, as not to be distinguishable from the inflammation of the sulphur ; but the grains at a little distance from the coals will emit, after some time, a small, blue, lambent flame, which at
length

length becomes brighter ; the intenseness of the fire increases, and the gradual destruction of the saltpetre is clearly discernible ; some of the grains are consumed, while in others the blue flame disappears without producing their destruction : at length the more distant grains become warm, without emitting any flame or being consumed. This may be exemplified by putting some large grains of powder on an iron plate, which may be put near to, or drawn back from the fire, in order to give it different degrees of heat ; or by directing upon them the solar rays, united by means of a convex glass, as different degrees of heat may be produced by augmenting or diminishing the circle formed by the re-union of the rays.

These experiments prove that powder, like other combustible bodies, may become hot or inflamed, without being in the same instant consumed. It is necessary, therefore, to distinguish between the inflammation and the final destruction of each grain : for fire, when applied to two grains of different

ferent fizes, does not always cause any sensible difference in their destruction ; yet there is a great difference in the force of two equal quantities of powder, made with the same proportion of ingredients, of the same quality, but differently granulated, as is seen on comparing cannon and musquet powder.

Having ascertained those two properties, it remains to demonstrate, that when fire is applied to grains of powder, the inflammation of the contiguous grains, and the destruction of each individual grain, takes place progressively; and that the velocity with which fire spreads itself on all sides to inflame the contiguous grains, is greater than that with which it penetrates into the substance of each grain. It is too obvious to need insisting on, that all motion, however rapid or short it may be, takes up a certain time; though to us, from the shortness of its duration, it appears instantaneous: consequently, the inflammation and entire destruction of powder, produced by the action of fire, communicating itself to every thing
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around, like rays from a centre, must necessarily take place in a determined space of time ; which varies according to the strength of the fire, the proportion of the ingredients, the nicety of the mixture, and the size of the grains.

When a sufficient degree of fire is applied to one grain of powder, it first acts upon the surface, and then penetrates towards the centre. As the surface burns, a flame is excited, which catches the nearest grains, if the degree of heat be sufficient, and the surrounding air not too much rarefied. In the mean time, the fire which attacked the first grain, continues its action towards the centre till it be totally consumed.

There are then two distinct actions in the inflammation and the total consumption of powder : the first is the expansion of the inflamed fluid ; which spreading itself from the surface of the burning grains, surrounds the contiguous ones : the second is the penetration of the fire from the surface of each grain towards its centre. But the flame always spreads with more rapidity between
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the intervals of the other grains, than it penetrates towards the centre of each grain.

The following observation will prove that a determined time is requisite for the consumption of each grain. Make of the common mixture, some grains of powder as large as pistol bullets ; dry, and set fire to them : it will then be seen that the fire penetrates from the surface to the centre, in a longer or a shorter space of time according to the size of the grains ; so that if there be no other difference between these large grains and common ones than in size, it may be inferred, from analogy, that the smallest must require a certain space of time, however short. It is likewise clear, that the flame, in spreading itself from the burning grains to the contiguous ones, takes up a certain space of time ; as may be exemplified by setting fire to a train of powder. But it is not sufficient to have proved that the burning of each grain, and the inflammation of the contiguous ones, are progressive ; it is necessary further to shew, that the activity

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with which fire spreads itself between the interstices of the grains, is greater than that with which it penetrates from the surface toward the centre of each grain. If we consider that the inflamed fluid, in passing between the grains, meets no other resistance than the common air, which is easily penetrated, by reason of its rarefaction; and that the fire, in insinuating itself from the surface toward the centre of the grain, must pass through a substance much more dense; it is evident that, the resistance in the second case being greater than in the first, the fire must consequently be slower in its progress.

The following experiment will serve in proof of this assertion. Let a pistol barrel, with the vent closed up, be filled with powder to the muzzle: on applying fire to it, the barrel will instantly empty itself, with an explosion. Let it be again filled with powder well compressed, so that the interstices between the grains may be as small as possible, and form, as it were, a solid body;

body; the time that the barrel will take to empty itself will be sensibly longer than before.

The great velocity with which the inflamed fluid passes from the muzzle to the breech of the pistol barrel, between the interstices of the grains, is observable in the first experiment; and in the second, it is seen how much this velocity, from the necessity of penetrating the powder itself, is retarded.

From the three preceding paragraphs, the following principles are deducible.

That in burning two equal quantities of powder, made of the same composition, but differently granulated, as cannon and musket powder, the latter will be consumed in less time than the former; because the grains being smaller present to the fire a greater superficies, and produce, at the first instant, the inflammation of a greater quantity of matter; which is consumed so much the sooner, as the fire has less space to pass through from the surface to the centre of each grain. That this depends not only

upon the size of the grains, but also upon the facility with which the fire passes between them. On the other hand, the grains should not be too small; for then the interstices will be so diminished, as to admit the flame to pass with difficulty; and they will be so compact, as to form, as it were, a solid body.

The grains of powder are generally of a very irregular form and uneven surface; whence arise many varieties in the quickness of its inflammation and explosion. To remedy these inconveniences, some manufacturers put the powder into a barrel suspended by two pivots; and having turned it for some time, separate, by means of a screen, the dust from the grains, which are, by this operation, sufficiently smoothed and rounded. On comparing powder made in this manner, with powder of an irregular form and uneven surface, the latter is found to take fire more quickly, though the proportion of ingredients be precisely the same in both. Nevertheless, as the interstices between the round grains are larger than between grains of an irregular figure, and as upon them the

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quickness

quickness of the inflammation greatly depends, the round grains may be so small, that the interstices being equal in both, the fire may be able to spread itself equally, and consume the powder with the same rapidity; and as powder of an irregular grain takes fire more easily than smooth-grained powder, a proportional size might be fixed on which would cause the latter to inflame with greater, or at least equal promptitude.

As these properties are common to all kinds of powder that are well made, of proper materials, and equally dried, varieties in their effects can only result from the different proportion of the ingredients, the size of the grains, their figure, and smooth or uneven surface. If the ingredients, however good in quality, are not well mixed together, the powder will not so readily burn, and the difference of the effects will be very sensible.

The common air that is within and between the grains contributes likewise, by its expansion, to the force of the powder

when fired. Its absolute force might be easily determined; but is very small, in comparison of the elasticity of the permanent fluid generated from powder. Some, however, pretend to have ascertained, that in six grains of powder there is at least one grain of pure air in a very compressed state.

Thus the diminution of the ranges of fire arms, when heated by frequent discharges, or when the air of the atmosphere is more rarefied, ought not to be attributed to less elasticity in the air, but rather to the second property of powder; where, being fired in a rarer medium, less takes fire, though the same quantity be used; and hence the range is shortened, as may be clearly proved by various experiments.

For the same reason, the increase of force obtained by triturating powder for a long time, and the force which damaged powder resumes after having undergone a fresh process, proceed not, as some think, from the greater quantity of air compressed into the substance of the powder, but simply from

from a more exact mixture of the ingredients, whence they more easily and generally take fire.

In illustration of this remark, it is sufficient to observe, that the best manufactured powder is liable to be damaged by excessive heat or moisture. The powder-makers, in drying powder, take care to stir it frequently, and suffer it to cool before they put it into the barrels; as they pretend that it ferments when very hot: and in fact, if, when much heated, it be closed up in a barrel for some hours, and afterwards poured gently upon a cloth, a great part of the grains, especially those towards the middle of the barrel, will be caked together; on examining them carefully, it will be found to be owing to the great heat, which having liquefied the sulphur, it glues the grains together when cold: but this never happens if the powder be allowed to cool before it is put into the barrel.

A partial or total liquefaction of the sulphur is always prejudicial to the inflammation

flammation and quick destruction of the powder, as it destroys the exact mixture of the ingredients, which can only be recovered by subjecting it to a fresh process. If the heat be not sufficient to liquefy the sulphur, a large quantity of dust, consisting principally of sulphur and charcoal, will be found in barrels of powder that have been long manufactured and exposed to damp.

The powder from which this dust is detached will be altered in quality; and while the interior of the grains, from which the sulphur and charcoal are fallen off, continue in the same state they were in when made, the exterior will have lost the greater part of the substances necessary to facilitate the inflammation.

Thus, on applying fire to these grains, the surface burns slowly till the fire penetrates the interior, and meets a sufficient quantity of sulphur and charcoal; the powder must therefore have become weaker. Now, if the powder, thus reduced in strength, be manufactured again, the grains will become homogeneous, both internally
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and externally ; but, owing to the diminution of the quantity of sulphur and charcoal, they will be altered in quality, since the saltpetre will be in greater proportion than either of the other two ingredients ; so that if, before the powder became damp, it was not very strong, it will now have become much stronger ; but, on the contrary, if it was as strong as possible before, and the ingredients well proportioned and intimately mixed together, it will in this new operation have lost part of its strength. Hence it may be inferred, that grinding serves only to mix the ingredients together ; and that when there is a perfect contact between the nitrous and combustible particles, it is useless any longer to continue the operation.

Powder, however well dried and fabricated it may have been, loses its strength when allowed to become damp. If daily observations on powder put into damp magazines, and carefully preserved in barrels, are not sufficient to establish
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this fact, the following experiment will render it incontestable.

Let a quantity of well dried powder be nicely weighed, and put into a close room, where the air is temperate, and seemingly dry, and be left for three or four hours; on weighing it again, its weight will be increased. This same powder, exposed to an air loaded with vapour, acquires much additional weight in a short time. Now the increase of the weight being proportional to the quantity of vapour contained in the atmosphere, and to the length of time that the powder is exposed to it; it follows, that powder easily attracts moisture.

Wherefore, if a degree of heat, sufficient only to fire dry powder, be applied to powder that is damp, the moisture will oppose the action of the fire, and the grains either will not take fire at all, or their inflammation will be slower: thus, as the fire will spread more slowly, fewer grains will burn; and the penetration
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of the fire from the surface to the centre of each grain, and consequently their consumption, will require more time. Whence it may be concluded, that all degrees of moisture diminish the force of powder. Saltpetre, not sufficiently refined, attracts moisture very readily; and as the substances that render it impure lessen the quantity of fluid, and prevent its detonation, it should be refined as much as possible before it is employed in the fabrication of gunpowder.

Having thus shewn that the force of powder is owing to an elastic fluid generated at the explosion, the suddenness of which depends upon the proportion of the ingredients, the contact between the nitrous and combustible particles, and the size of the grains, &c. it may be concluded, that when several powders, equally well dried, and fired under the same state of the atmosphere, are compared together, that which produces the greatest quantity of the elastic fluid, in a given space of time, is the strongest.

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There are two general methods of examining gunpowder; one with regard to its purity, the other with regard to its strength.

Its purity is known by laying two or three little heaps near each other upon white paper, and firing one of them. For if this takes fire readily, and the smoke rises upright, without leaving any dross or feculent matter behind, and without burning the paper, or firing the other heaps, it is esteemed a sign that the sulphur and nitre were well purified, that the coal was good, and that the three ingredients were thoroughly incorporated together: but if the other heaps also take fire at the same time, it is presumed, that either common salt was mixed with the nitre, or that the coal was not well ground, or the whole mass not well beat and mixed together; and if either the nitre or sulphur be not well purified, the paper will be black or spotted.

For proving the strength of gunpowder, a number of machines have been invented, all of which are liable to many objections,
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and upon trial with the same powder, are found to give results so different, that no dependence can be placed in them; to so many modifications are the principal properties of powder subject, even in experiments conducted with the utmost care. These variations have been attributed, by many, to the different density of the atmosphere at the time of the different experiments; but the opinions upon this matter are so improbable in themselves, and so contradictory to each other, that they claim neither attention nor belief. Thus, some will have it, that gunpowder produces the greatest effect in the morning and evening, when the air is cool and dense; whilst others assert, that its force is greatest in sunshine, and during the heat of the day. Mr. Robins concludes from the result of several hundred trials, made by him at all times of the day, and in every season of the year, that the density of the atmosphere has no effect in this matter, and that we ought to attribute the variations observed at these times, to some other cause than the state of the air :
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probably they are owing to the imperfection of the instrument, or to the manner in which the trial was conducted. In this state of uncertainty then upon the theory of the effects of gunpowder, we remain at this day.

If experiments, however, are made with the prover, great care must be taken, not to press the powder in the smallest degree into the tube of the instrument, but to pour it gently in ; and particularly in trying the strength of different powders, which is the best use to which the instrument, imperfect as it is, can be applied, attention must be paid, that one powder is not pressed closer than another at each experiment, nor the successive experiments made until the prover is cool, otherwise no comparative certainty can be gained.

By far the most certain method, however, of determining the quality of powder, is by drying some of it very well, and then trying how many sheets of paper it will drive the shot through, at the distance of ten or twelve yards. In this trial we should be

careful to employ the same sized shot in each experiment, the quantity both of the shot and the powder being regulated by exact weight; otherwise we cannot, even in this experiment, arrive to any certainty in comparing the strength of different powders, or of the same powder at different times.

Powder ought to be kept very dry; every degree of moisture injures it. Good powder, however, does not readily imbibe moisture; and, perhaps, there is no greater proof of the bad quality of powder, than its growing damp quickly when exposed to the air: this readiness to become moist, depends upon the saltpetre employed in the composition not having been freed from the common salt it contains in its crude state, and which in consequence has a very strong attraction for watery particles.

Powder may acquire a small degree of dampness, and be freed from it again by drying, without much injury to its quality. But if the moisture is considerable, the saltpetre is dissolved, and the intimate mixture
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of the several ingredients thereby entirely destroyed. Drying powder with too great a heat also injures it ; for there is a degree of heat, which, although not sufficient to fire the powder, will yet dissipate the sulphur, and impair the composition by destroying the texture of the grains. The heat of the sun is, perhaps, the greatest it can with safety be exposed to, and, if properly managed, is sufficient for the purpose: when this cannot be had, the heat of a fire regulated to the same degree, may be employed; and for this end, a heated pewter plate is perhaps as good as any thing, because pewter retains so moderate a heat, that there can be little danger of spoiling the powder by producing the consequences before mentioned.

It is observable that damp powder produces a remarkable foulness in the fowling piece after firing, much beyond what arises from an equal quantity of dry powder ; and this seems to arise from the diminution of the activity of the fire in the explosion.

Unless the sportsman is very particular indeed

deed in the mode of keeping his powder, we would recommend him always to air it and his flask, before he takes the field.

Flasks made of copper or tin, are much better for keeping powder in than those made of leather, or than small casks: the necks of these should be small, and well stopped with cork.

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THE choice of this article is highly worthy of the sportsman's care. It should be equal, round, and void of cavities. *The patent milled shot* is, at this time, to be preferred to all other sorts, and is in such general use, that the instructions which here follow on the size of shot to be adopted in the different chaces, must be understood to relate to the Patent Shot only.

The difference, however, which subsists between the sizes of patent and of common shot, will be hereafter shewn by means of a table, denoting the number of pellets contained

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tained in a given weight of each ; so that in cases where the former cannot be procured, it will be easy to adapt the rules there laid down, to the latter, by only taking the same number of grains in the common, as directed to be used for the patent shot.

It is extremely important for the success of the chase, that the sportsman should proportion the size of his shot, as well to the particular species of game he means to pursue, as to the season of killing it. Thus, in the first month of partridge shooting, shot No. 1. should be used ; for since, at this time, the birds spring near at hand, and we seldom fire at more than the distance of forty paces, if the shooter takes his aim but tolerably well, it is almost impossible for a bird at this distance to escape in the circle, or disk, which the shot forms.

Hares also, at this season of the year, sit closer ; and being at the same time thinly covered with fur, may easily be killed with this sized shot, at thirty or thirty-five paces.

In snipe and quail shooting, this sized shot is peculiarly proper ; for, in using a
larger

larger size, however true the sportsman may shoot, yet he will frequently miss; the objects being so small, that they have great chance of escaping in the vacant spaces of the circle or disk. Yet there are many sportsmen who shoot snipes, quails, and fieldfares, in countries where they abound, with the sizes *six* and *seven* of the common shot, the last of which is called mustard-seed.

About the beginning of October, at which time the partridge are stronger in the wing, *number three* is the proper shot to be used. This size seems to be the best of any; it preserves a proper medium between shot too large, and that which is too small, and will kill a hare, from the distance of thirty-five to forty paces; and a partridge at fifty; provided the powder be good. It will serve also for rabbit shooting. In short, it is excellent for all seasons, and many sportsmen use no other the season round.

It is true, that distant objects are frequently missed for the want of larger shot; but then these bear no proportion to the number which are daily missed, by using shot of too

large a size, especially with the feathered game. If a man was to shoot constantly with shot *number five*, for one partridge which he might chance to kill with a single pellet, at the distance of eighty paces, he would miss twenty birds at fifty paces, which would in such case escape in the vacant spaces of the circle. But if the sportsman expressly proposes to shoot wild-ducks, or hares, then, indeed, he had better use the *number five*. However, in shooting with a double-barrelled gun, it may be prudent to load one of the barrels with large shot, for the necessary occasions ; and if in any case large shot is required, *number five* will be found to be better than any other ; for its size is not so large as to prevent it from sufficiently garnishing, or being equally spread in the circle, and it can at the same time perform, in effect, all that a larger-sized shot can do, which garnishes but very little, if any at all.

In order, therefore, to shew clearly, and at one view, the comparative difference in the garnishing of shot of different sizes ; we here subjoin a table, which indicates the
num-

number of pellets precisely composing an ounce weight of each sort of shot, the patent and the common, commencing at the smallest size in each.

PATENT SHOT.

No.	8	1 ounce	- - -	620
	7	id.	- - -	480
	* x	id.	- - -	300
	1	id.	- - -	220
	2	id.	- - -	180
	3	id.	- - -	157
	4	id.	- - -	105
	5	id.	- - -	83

* The Reader will observe, that the patent shot has no No. 6, the x being substituted in its place, and that the numbers do not follow each other in the order of progression: the reason of this we cannot assign.

We have been lately informed, that the manufacturer of this shot has, with a sufficient degree of caprice, totally altered the numbers, to the great inconvenience of the shooter, who, in ordering the former numbers, has different sizes than formerly sent him.

COMMON SHOT.

No.	7	1	ounce	-	-	-	350
	6		id.	-	-	-	260
	5		id.	-	-	-	235
	4		id.	-	-	-	190
	3		id.	-	-	-	140
	2		id.	-	-	-	110
	1		id.	-	-	-	95

The Proportions of Powder and Shot in the Charge.

TO find the charge that gives the longest range in fowling pieces of different dimensions, must be allowed to be a discovery of infinite importance to every sportsman; and as it seems to be an opinion pretty generally received and established, that every barrel has a *particular* load (not a measure estimated by any rules to be drawn from a comparison made between the proportions of the caliber and the length of the barrel) with which it will shoot with greater certainty

tainty and effect ; it cannot be doubted that he will make some experiments with his own barrels, in order to attain this end. Before we proceed, therefore, to lay down a few general rules for the loading of fowling pieces of different dimensions, we beg leave to engraft an excellent principle, in the practice of the Artillery on this point, upon the shooting science. It is asserted, that by using small charges at first, and increasing the quantity of powder by degrees, the ranges will increase to a certain point ; after which, if the charge be augmented, they will progressively diminish ; though the recoil will still continue in the ratio of the increase of the charge. This is a consequence that may be deduced from a variety of experiments, and is perfectly agreeable to the principles of mechanics ; since the recoil and the range ought to be in the reciprocal ratio of the gun and the shot, making allowance for the resistance which these bodies meet with.

For a fowling piece of a common caliber, which is from twenty-four to thirty balls to the pound weight ; a dram and a quarter,

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or,

or, at most, a dram and a half, of good powder; and an ounce, or an ounce and a quarter, of shot, is sufficient. But when shot of a larger size is used, such as *number five*, the charge of shot may be increased one-fourth,* for the purpose of counterbalancing, in some degree, what the size of the shot loses in the number of pellets, and also to enable it to garnish the more. For this purpose, the sportsman will find a measure marked with the proper gages, very convenient to him. An instrument of this nature has been made by an ingenious artist of this town, Egg, of the Haymarket.

Different opinions, however, are entertained on the proportions of the charge. Some determine the charge of a fowling piece, by the weight of a ball of the exact size of the caliber; estimating the weight of the powder at one-third of that of the ball, whether it is proposed to shoot with ball or with shot; and the weight of the shot they estimate at amoiety more, or, at the most, at double the weight of the ball. This calculation comes pretty near to the
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proportions we have just laid down, except in the difference of size between the calibers twenty-four and thirty, which, notwithstanding, is not sufficiently great in the two cases, to require a gradation in the weight of the charge.

Others again lay down as a rule for the charge of powder, a measure of the same diameter as the barrel; and double that diameter in depth: and for the shot, a measure of the like diameter, but one-third less in depth than that for the powder. This also agrees tolerably well with the proportions we have mentioned, at least for the powder, but the measure of shot seems to be too small.

In shooting ball with a rifle piece, some persons proportion the quantity of powder, to three times the quantity which the mould of the ball adapted to the piece, will contain.

Although proverbs are generally true, or at least possess some portion of truth; yet nothing is so glaringly absurd, or less founded in rational principles, than that old adage,
“*sparing*

“sparing of powder, and liberal of shot :” a saying, which is not only in the acquaintance, but in the constant practice of most sportsmen.

As a consequence of overloading with shot, the powder has not sufficient strength to throw it to its proper distance ; for if the object fired at be distant, one-half of the pellets composing the charge, by their too great quantity and weight, will strike against each other, and fall by the way ; and those which reach the mark, will have small force, and will produce but little or no effect. Thus to overload, is the strange fancy of poachers, who imagine they cannot kill unless they put two ounces, or more, of large shot into their pieces. It is true, that they destroy a great quantity of game, but then it is not fairly shot. Such men are in some measure punished by the severe strokes they receive on the shoulders and cheeks, in consequence of the excessive recoil.

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WADDING.

MANY sportsmen are of opinion, that the wadding, of whatever material it may be composed, or whether it be rammed loose, or tight, into the barrel, has no effect, either on the range of the shot, or the closeness with which they are thrown. Now, although it may be granted, that the material which covers the shot, and which is used only for the purpose of keeping it down, is of little importance, yet, the substance which covers the powder is undoubtedly of much consequence. It should be quite close in the barrel, and that without being rammed too hard; the wadding should therefore be of a soft and tractable material, but at the same time of sufficient consistence, to carry the shot in a body, to a certain distance from the muzzle of the piece. For, if the wadding is rammed too close, or is of a hard and rigid substance, such as stiff brown paper, the piece will recoil, and the shot will spread more wide: if, on the contrary, the wadding is not sufficiently

ficiently close, and is composed of a slight and too pliant a material, such as wool or cotton, it will not be of consistence enough to carry the shot, and the discharge will lose its proper force. Besides, a certain portion of the shot which is more immediately in contact with the wadding, will be melted by the explosion of the powder.

In the former part of this treatise, where we treated of the *shot* of fowling pieces, we have given our reasons for preferring wadding made of hat, by means of a punch fitted to the bore of the piece, to every other ; but as this is not easily procured in sufficient quantity, we must employ something that is at once cheap, and adequate to the purpose.

Next to hat, therefore, experience teaches, that nothing is better for wadding than soft brown paper ; it combines suppleness with consistence, and moulds itself to the barrel : and it is further observable, that such wadding never falls to the ground, in less than twelve or fifteen paces from the muzzle of the piece.

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In countries where orchards abound, a very fine moss, of a greenish grey colour, is found adhering to the apple trees, which is extremely proper for wadding, and which even possesses the extraordinary quality, of making the barrel less greasy and foul than paper, which always contains a certain quantity of oil. Tow is also very good for this purpose. A cork wadding has been extolled for the virtue of increasing the range and closeness of the shot of pieces ; we have not made the experiment, but it seems probable, that a wadding of cork, adapted to the caliber of the piece, may produce a greater effect, than a wadding of paper, in these respects, that by stopping the barrel more hermetically, it prevents the elastic fluid, produced by the explosion of the powder, from escaping in any way, between the partition of wadding and the charge, preserves all its force to the mouth of the gun, and thereby renders the effect of the powder greater. These principles have been already applied to the wadding of hat, and to which therefore we refer the reader.

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We have now, however, to speak of another species of wadding, and which has novelty, at least, to recommend it; but, in truth, it may be preferred to hat wadding, for the principles of that equally apply to this, and it possesses one great advantage in the circumstance of not fouling the barrel so much as the other. The wadding to which we allude is made of the cloth called *Fearnought*, or *Shepherds Cloth* (which is very generally known), and punched by the same instrument as formerly mentioned for hat wadding; but it must not be *dyed*, for the acid which is used to *set* the colour will rust the inside of the barrel immediately in contact with it, and especially if the gun is laid by charged. Some sportsmen use it upon both the powder and shot; but by experience we find, in proof of our former opinion on this matter, that it should only cover the powder; for, when laid upon the shot, they are, in consequence, more scattered in the discharge.

We also find, that wadding composed of this material is much cheaper than hat :
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the cost is from 1s. 6d. to 2s. per yard, according to the quality and thickness, and a yard will cut into 1536 pieces of wadding for a barrel of a common caliber.

As wadding, either of hat or the cloth we have just mentioned, is apt (if the ramrod is not sufficiently broad at the top) to be driven down edgeways, we recommend the sportsman to put it down with the screw-end, giving the screw a single turn round into the cloth, and when it reaches the powder, to turn the other end of the ramrod and fix it level, using no force in ramming it home, and keeping the gun as nearly perpendicular as possible during the operation.

CHAP. XIII.

Method of loading a Fowling Piece.

SOME attention is requisite in loading a piece; the powder should be only slightly rammed down, for which purpose, it is sufficient to press the ramrod two or three times on the wadding, and not (as the usual practice is) to ram down the wadding by main force, by drawing up the ramrod, and then returning it into the barrel with a jerk of the arm, many successive times. For, by compressing the powder in this violent manner, some of the grains will necessarily be bruised, whilst the explosion will not be so quick, and the shot will be spread wider.

In pouring the charge of powder into the barrel, care should be taken, to hold the measure as much as possible in a perpendicular

cular line, that the powder may the more readily fall to the bottom. It is even of service to strike the butt end of the gun on the ground, in order to detach those grains of powder, which, in falling down, adhere to the sides of the barrel.

The shot should never be rammed down tight: after having given a stroke on the ground with the butt end of the gun, in order to settle it, the same as for the powder, the wadding should then be gently put down, but much less close than that over the powder; for when the shot is wadded too tight, it spreads wide, and the piece will recoil. In this, therefore, as well as in every other mode of loading, the sportsman should never carry his gun under his arm, with the muzzle inclined to the ground; that practice at all times loosens the wadding and charge too much, sometimes produces the loss of the shot, and always indicates laziness in the shooter, and indifference to the sport.

When the piece is fired, it should, if pos-

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sible,

fible, be re-loaded immediately, whilst the barrel is warm, lest by delaying it, a certain moisture should be formed in the barrel, which would retain a part of the powder when pouring in the charge, and hinder it from falling to the bottom.

Powder, also, as already mentioned, will imbibe moisture from the air, and therefore it is of additional advantage, to load the piece whilst the barrel is warm, because some part of the moisture will be thereby evaporated.

For the same reasons, the sportsman should fire off a little powder before he loads the first time, for it has been found, even in the driest seasons, that the coldness of the barrel, and perhaps some little moisture condensed in its cavity, have sensibly diminished the force of the powder, in the first discharge.

Some sportsmen prime before they load : this may be proper when the touch-hole is enlarged, and the barrel is very thin at that place, because, in that case, if the piece is not first primed, it will in loading prime
itself,

itself, which diminishes the charge; but when the touch-hole is of its proper size, the piece should never be primed until after it is loaded; for then it will be known from the few grains of powder which usually make their way into the pan, that the touch-hole is clear and unobstructed; and on the contrary, if no grains come through, that it will be proper to strike the butt of the gun smartly with the hand, and to prick the touch-hole until they appear.

But, whether the practice is to prime before or after loading the piece, it is highly proper, after every discharge, to prick the touch-hole, and what is still better, to guard against all remains of fuze or squib, by inserting into the touch-hole the feather of a partridge's wing, which will not only clear it of these dangerous remains, but, if the piece is delayed to be re-charged, will take away all humidity that may be contracted there.

CHAP. XIV.

Instructions for Shooting well.

EVERY sportsman has his own manner of bringing his gun up to his shoulder, and of taking aim; and each follows his own fancy with respect to the stock of his fowling-piece, and its shape. Some like it short, others long; one prefers it straight, another bent.

And although there are some sportsmen, who shoot equally well with pieces stocked in different ways and shapes, yet certain principles may be laid down, as well upon what is the proper length, as upon the proper degree of bent, that the stock of a gun should have. But in the application, those principles are very frequently, nay most commonly counteracted, by the

whim, or the particular convenience of the shooter.

Generally speaking, however, it is certain, that for a tall, long-armed man, the stock of a gun should be longer, than for one of a less stature, and shorter arm. That a straight stock is proper for him who has high shoulders, and a short neck; for, if it be much bent, it would be very difficult for him, especially in the quick motion required in shooting at a flying or running object, to place the butt of the gun-stock firmly to the shoulder; the upper part alone would in general be fixed, which would not only raise the muzzle, and consequently shoot high, but make the recoil be much more sensibly felt, than if the whole end of the stock were firmly placed on his shoulder. Besides, supposing the shooter to bring the butt home to his shoulder, he would scarcely be able to level his piece at the object. On the contrary, a man with low shoulders, and a long neck, requires a stock much bent; for, if it is straight, he will, in the act of lowering

his head to that place of the stock at which his cheek should rest, in taking aim, feel a constraint, which he never experiences, when, by the effect of the proper degree of bent, the stock lends him some assistance, and, as it were, meets his aim half way.

Independent, however, of these principles, the application of which is subject to a variety of modifications; we venture to advise the sportsman in the choice of a fowling piece, that a long stock is preferable to a short one, and at the same time, rather more bent than usual; for a long stock sits firmer to the shoulder than a short one, and particularly so, when the shooter is accustomed to place his left hand, which principally supports the piece, near to the entrance of the ramrod into the stock.

The practice of placing that hand near the bridge of the guard, is, undoubtedly, a bad one; the aim is never so sure, nor has the shooter such a ready command over his piece, as when he places his hand near the entrance of the ramrod, and, at the same time, strongly grasps the barrel; instead

stead of resting it between his fore-finger and thumb, in conformity with the general custom. It may, therefore, be depended upon, that a stock, bent a little more than ordinary, is better for shooting true, than one too straight, because the latter, in coming up to the aim, is subject to the inconvenience of causing the sportsman to shoot too high.

We would also advise him to have his fowling-piece a little elevated at the muzzle, and the sight small and flat; for, the experienced well know, that it is more usual to shoot low than high. It is, therefore, of service, that a piece should shoot a little high, and then the more flat the sight, the better the line of aim will coincide with the line of fire, and of consequence, the gun will be less liable to shoot low.

The method by which to avoid missing a cross shot, whether it be flying, or running, is, not only to take aim before the object, but likewise not involuntarily to stop the motion of the arms, at the mo-

ment of pulling the trigger ; for the instant the hand stops in order to fire, although the space of time is almost imperceptible, the object, if a bird, gets beyond the line of aim, and the shot will fly behind it ; and if a hare or rabbit is shot at in this manner, whilst running, and especially if at a distance, the animal will only be slightly struck in the buttocks, and will be taken but by hazard. When a bird, however, is flying in a straight line from the shooter, this fault can do no harm ; the object can scarcely escape, if the piece be but tolerably well directed, unless, indeed, it is fired at the moment the game springs, and before the birds have taken a horizontal flight. In that case, if the hand should stop ever so little, at the instant of firing, the sportsman will shoot low, and inevitably miss the mark.

It becomes, therefore, extremely essential to accustom the hand, in taking aim, to follow the object, without suspending the motion in the least degree, which is

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a capital point towards acquiring the art of shooting well : the contrary habit, which it is very difficult to correct, when once contracted, prevents that person from attaining perfection in the art, who, in other respects, may eminently possess quickness of sight, and steadiness of aim.

Nor is it less essential in a cross shot, to aim before the object, in proportion to its distance, at the time of firing. If a partridge, for instance, flies across at the distance of thirty, or five-and-thirty paces, it will be sufficient to take aim at the head, or, at most, but a small space before. The same rule will nearly hold in the cases of shooting quail, woodcock, pheasant, or wild duck, although those birds move their wings slower than the partridge. But, if the object is fifty, sixty, or seventy paces distant, it then becomes necessary to aim at least half a foot before the head.

The same practice should be observed, in shooting at a hare, or rabbit, when running in a cross direction, making due allowance for the distance, and for the
swiftness

swiftness of the pace, which is not always the same.

It is also proper, in shooting at an object very distant, to take aim a little above it, because shot, as well as ball, have but a certain range in point blank, beyond which, each begins to describe the *curve* of the *parabola**.

When a hare runs in a straight line from the shooter, he should take his aim between the ears, otherwise he will run the hazard either of missing, or at least of not killing dead, or, as it is sometimes called, "*clean*." A true sportsman, who has the ambition of shooting well, is not content with only breaking the wing of a partridge, or the

* Some authors celebrated for their mathematical Tracts on Gunnery, are of a different opinion as to the track described by the ball in its flight. We will here only mention Euler, a German writer, who insists that, the resistance of the air to swift motions being very great, the curve described by the ball is neither a parabola, nor near it; and after various algebraic proofs, he infers, that, by reason of this resistance, the angle which gives the greatest amplitude is not forty-five degrees, as commonly supposed, but something less.

thigh

thigh of a hare, when he shoots at a fair distance; for in such case, the hare, or the partridge, ought to be shot in such a manner, that it should remain in the place where it falls, and not require the assistance of the dogs to take it.

———Now mercy goes to kill,
And shooting well is then accounted ill.
Thus will I save my credit in the shoot;
Not wounding, pity would not let me do't.

SHAK.

But, if he shoots at a great distance, it is no reproach that the partridge is only winged, or the hare wounded, so that it cannot escape.

Practice soon teaches the sportsman the proper distance at which he should shoot. The distance at which he ought infallibly to kill any kind of game, with patent shot, No. 3. provided the aim be well taken, is, from twenty-five to thirty-five paces, for the footed; and from forty to forty-five paces, for the winged game. Beyond this distance, even to fifty, or fifty-five paces,

paces, both partridge and hares are sometimes killed, but, in general, the hares are only slightly wounded, and carry away the shot; and the partridge, at that distance, present so small a surface, that they frequently escape untouched between the vacant spaces of the circle. Yet, it does not follow that a partridge may not be killed with No. 3. patent shot, at sixty, and even seventy paces distance, but then these shots are very rare.

Those who know the range of a fowling-piece, and the closeness of its shot, shrug up their shoulders at the romances of those sportsmen, who, by their own accounts, daily kill, with shot No. 3. at the distance of ninety, and one hundred paces. Nay, some even go so far, as to assert, that they have killed, with this sized shot, hares, at one hundred and ten paces, and pheasants, at one hundred and twenty. It cannot, however, be denied, that with shot No. 5. a man may have killed a hare or a partridge at one hundred and ten, or possibly at one hundred and twenty paces; but then these
shots

shots are so extraordinary, and occur so seldom, that the whole life of a sportsman will scarcely afford more than two or three instances ; and, when it does happen, it will be found to be by a single pellet, which, by great chance, has hit either the wing or the head of the partridge, or has struck the head of the hare, by which he is stunned, or, perhaps, has penetrated the small part of the shoulder, where there is, to prevent the wound being mortal, only a very thin skin, which being stretched by the animal in running, is thereby rendered more easy to be pierced with the shot.

As a means of attaining the art of shooting flying, many young sportsmen are advised to shoot at swallows ; but the flight of these birds is so irregular and swift, and at the same time so unlike the motion of those birds which are the object of sport, that we think it a bad method. No mode is so advantageous as the actual practice of shooting the game, whereby that trepidation and alarm, which most men feel upon the rising of the covey, will be sooner conquered ; for,
while

while these are possessed, even in the most trifling degree, no one will attain to be a steady and good shot.

This opinion is confirmed and enforced by such beautiful and descriptive language in the poem we have before cited, that we are tempted to give another quotation from the same work, not doubting that our readers will excuse us.

But vainly shall preceptive rules impart
A perfect knowledge of this manly art;
Practice alone can certain skill produce,
And theory confirm'd by constant use.
The hardy youth, who pants with eager flame
To send his leaden bolts with certain aim,
Must ne'er with disappointed hopes recoil
From cold and heat, from hunger and from toil;
Must climb the hill, must tread the marshy glade,
Or force his passage through th' opposing shade;
Must range untam'd by Sol's meridian pow'r,
And brave the force of winter's keenest hour,
Till industry and time their work have wrought,
And honour crown the skill that labour taught.
Yet some, these harsher rudiments to spare,
And equal art with easier toil to share,

Or

Or watch with careful aim and ready fight
The swallow wheeling in her summer flight,
Or on some lofty cliff, whose chalky steep
Hangs with rude brow impending o'er the deep,
Where gulls and screaming sea-mews haunt the rock,
Pour fire incessant on the mingled flock.
But vain their hopes—presented to the eye
In such diversive lines the objects fly,
That the 'maz'd fight unnumber'd marks pursues,
Uncertain where to aim, and which to choose;
Decision quick and calm, the shooter's boast,
By frequent change, is check'd, confus'd, and lost ;
And, guarded by irresolute delay,
Untouch'd shall future coveys fleet away.
More hurtful still to try with distant blow
To bring the percher from th' aerial bough.
How shall his thoughts, the level that prepare
With all the caution of mechanic care,
Exact and steady as the sage's eye
Through Galileo's tube surveys the sky,
With ready view the transient object seize
Swift as the motion of the rapid breeze,
Pursue th' uncertain mark with swift address,
And catch the fleeting moment of success ?

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If, however, there are persons who still think the practice of shooting swallows to be of assistance in acquiring the art, we will venture to recommend another mode, which is nearly similar, but, in our opinion, much better. This is, by putting small pieces of white paper round the necks of sparrows, or other small birds, by the means of a hole cut in the middle of the paper; then, throwing a single bird into the air, the young shooter may deliberately take his aim; for, by this device, the flight of the bird is rendered less rapid, and more regular, and at the same time presents a much better mark for practice. Besides, it affords an excellent diversion in seasons when game cannot be pursued, or in wet weather, from underneath the shelter of a shed, or a barn door. Some of the first shots in the kingdom have been perfected by this mode.

A fowling-piece should not be fired more than twenty, or five-and-twenty times, without being washed; a barrel, when foul, neither shoots so ready, nor carries the shot so far, as when clean. The flint, pan, and hammer,

hammer, should be well wiped after each shot; this contributes greatly to make the piece go off quick, but then it should be done with such expedition, that the barrel may be reloaded whilst warm, for the reasons we have before advanced. The flint should be frequently changed, without waiting until it misses fire, before a new one is put in. Fifteen or eighteen shots, therefore, should only be fired with the same flint; the expence is too trifling to be regarded, and by changing it thus often, much vexation will be prevented.

A gun, also, should never be fired with the prime of the preceding day; it may happen that an old priming will sometimes go off well, but it will more frequently contract moisture and fuze in the firing; then the object will most probably be missed, and that because the piece was not fresh primed.

For the use and convenience of those who love the sport of shooting water-fowl, we will here insert an infallible receipt to exclude water and dampness from penetrating their

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boots.

boots. For this purpose the boots should be made of soft cow leather, well seasoned, and rendered as much water proof as they can be, by the quality of the leather and the closeness of the sewing,

Take of Tallow, half a pound,
Hogs lard, four ounces,
Turpentine, two ounces,
New bees wax, two ounces,
Olive oil, two ounces.

Melt the whole together in an earthen pipkin over the fire, and stir it well while melting.

The night before it is proposed to go a shooting water-fowl, care must be taken, that the boots have no dampness; they must then be warmed gradually at a clear fire, and, when well heated, must be liberally anointed with the preceding composition, which should be previously melted to such a degree of heat that the hand can but just bear it; so much of this composition should be applied as the leather will suck up, in repeated rubbings. On the next morning, the boots will feel a little stiff in putting on,
but

but the warmth of the leg will soon render them supple. When the boots are new, it will be necessary to wear them two or three times before they are anointed, in order to take away the oily dressing which all new leather has.

With boots thus prepared, the sportsman may wade whole days in bogs and swamps, without fear either of wet or damp, being sure to return home with dry legs and feet.

C H A P. XVI.

General Instructions on Shooting.

NOtwithstanding the instructions which here follow, may appear minute and superfluous to the experienced sportsman, yet, we trust, the young shooter will not be sorry to find the elements of his profession, or to meet with that information which will in some measure supply the experience he wants ; for this reason we presume to lay down a few general precepts for his conduct in the pursuit of the game.

In the first place, he should pay attention to the difference of seasons, and the weather ; to the temperature of the air, and even to those hours of the day, which are more or less favourable for shooting. In warm weather he should hunt for the game in plains and in open grounds, at the same time bearing

bearing in mind, that, during the heat of the day, the birds frequent moist places, marshes where there is little water and much high grass, the sides of rivers and brooks, and hills exposed to the north. But, in cold weather, they will most commonly be found on little hills exposed to the south; along hedge-rows; among the heath; in stubbles; and in pastures where there is much furze and fern. In hard frosts, they get into thickets, low places, and marshes, where they seek to shelter themselves from the cold, as well as the heat, in different seasons. The greatest part, however, of these rules will only apply, when the weather is extremely hot, or severely cold, at both of which times, the hares and partridges almost totally desert the plains and open grounds. The game is more easily approached, or, in the language of sporting, "*lies better*," in covert, than in open places; a double advantage is therefore obtained, by hunting for them in the former.

He should, at all times of the shooting season, go out in the morning before the

dew is off. At that time, the shepherds and their flocks, the husbandmen and their teams, have not entirely spread over the fields, and have as yet sprung but a small quantity of game; the scents of the preceding night will also be more warm, and the dogs will hit them off better. Besides, if he is not early, he loses such opportunities of shooting, as he will not meet again, during the remainder of the day.

All these advantages, therefore, greatly counterbalance the notion generally received, that, as the birds will not lye well while the ground is wet, the sportsman should not go out early in the morning, or before the dew is gone off.

The colour of the dress which the shooter should wear, is worthy notice. Green is unquestionably the best in the early part of the season, whilst the leaves remain on the trees. For, if he is clad in a glaring colour, when the face of the country retains its verdure, the game will perceive his approach more easily, and from a greater distance. In winter, for the same reason, his dress
should

should be composed of a dark grey, or some colour resembling that of the dead leaf.

It is best to hunt as much as possible with the wind; not only to prevent the game from perceiving the approach of the sportsman and his dog, but also to enable the dog to scent the game at a greater distance. We say as much as possible, because in advancing and returning upon his steps, in order to range the ground well, the shooter cannot always keep the advantage of the wind. When, therefore, it is proposed to hunt any particular tract of country, in which game is expected to be found, it is indispensably necessary to take the wind, and it behoves the shooter to range and quarter his ground, in such manner and direction, as to preserve it in his favour.

He should never be discouraged from hunting and ranging the same ground, over and over again, especially in places covered with heath, brambles, high grass, or young coppice wood. A hare or rabbit will frequently suffer him to pass several times within a few yards of its form, without

getting up. He should be still more patient, when he has marked partridge into such places ; for it often happens, that after the birds have been sprung many times, they lye so dead, that they will suffer him almost to tread upon them, before they will rise. Pheasants, quails, and woodcocks do the same.

He should always keep a sharp eye, and carefully look round about him, never passing a bush, or tuft of grass, without examination ; but he should never strike either with the muzzle of his gun, for the reasons assigned when we treated of wadding. It is also proper to stop every now and then ; for this interruption of motion, frequently determines the game to spring, which would otherwise have suffered him to pass. He who patiently beats and ranges his ground over and over again, without being discouraged, will always kill the greatest quantity of game ; and if he is shooting in company, he will find game where others have passed without discovering any.

As soon as he has fired, he should call in
his

his dog, and make him lye down until he has reloaded his piece; for, without this precaution, he will frequently have the mortification to see the game rise, when he cannot shoot.

In shooting in an open country, one of the most essential points to be observed, is, to mark the place where the partridge alight; therefore, when he has killed his bird, he should not immediately run to pick it up, or attend to make his dog bring it to him, but he ought to follow the others with his eye, until he sees them settle, or as far as his sight can extend, without interruption from a wood or a hedge. In the latter case, although he has not been able to distinguish the exact spot on which they have alighted, yet he may tolerably well guess whereabout they are, especially if he is acquainted with the country in which he is shooting. And when two or more sportsmen shoot in company, each should mark the birds which fly on his own side.

The rules of conduct which we have just laid

laid down in shooting partridge, will with equal propriety apply to all the feathered game.

When a hare starts up at a distance, it is often of use to follow her with the eye, because she will sometimes squat down; and then, if she is left for a little space of time, she may be approached near enough to be shot on the form. But if she is perceived to enter a copse, or small wood, it is still better; in that case, the sportsman should cast his dogs through that part of the wood where he conceives it probable she has clapped down, and then he may wait for her on that side of the wood at which he thinks she will come out.

The description of a particular mode of killing game in an open country, may not be unacceptable to some of our readers. Eight men go in a company; four of them equipped with fowling-pieces, and four with sticks only, for the purpose of beating the bushes, furzes, &c. This band then range in a straight line, the beaters being placed in
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the intervals between the shooters, at the distance of ten or twelve paces, the whole forming a front of eighty or an hundred paces, so that in advancing they sweep a great tract of country. The beaters, in order to raise the game, make a great noise with their voices and sticks. When a covey of partridge springs, if one of the company fires, the rest stop until he has reloaded his piece, taking care in the mean time to mark the flight of the birds. If a single bird separates from the covey and is marked down, one of the shooters is dispatched after it, and the others halt until he returns.

Dogs are almost unnecessary in this sport; at least, one only should be used, which should be under perfect command, otherwise he should be held in a string, ready to be slipped in case of need, after a winged partridge, or a wounded hare. If a copse or small wood intervenes, the beaters enter and range it, while the shooters post themselves at the outlets.

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This method is much used in Italy; it is in general a very bloody sport, but seems to be more particularly adapted for places where the game is not in great abundance.

CHAP. XVI.

Instructions for Training Pointers.

BEFORE we enter into this matter, we beg the indulgence of our Readers whilst we say a few words in favour of that wonderful animal the Dog, and by describing a few of the extraordinary qualities he possesses, as well as his amiable disposition, prevail on the generality of the world to treat this faithful servant with more tenderness and respect in future.

Buffon, a man who possessed the greatest knowledge of nature and all her works, combined with the happiest talent of describing them, says that the dog, from the great perfection of his intellect, is worthy to enter in society with man; he knows how to aid him in his designs, to watch for his security, to assist him with his powers, to defend him, to flatter him; he knows, by assiduous services

himself to new trials of severity ; he licks the hand that strikes him ; to it he opposes only a mournful complaint, and at length disarms it by patience and submission.

More tractable than man, the dog not only imbibes instruction in a small space of time, but readily conforms himself to the various motions, to the manners, and to all the habits of the sportsman who commands him. Of what infinite importance is the dog in the order of nature, supposing for an instant that he had never existed ! Without him, how would man have been able to conquer, to subdue, and to reduce to slavery the savage animals of the forest ? How could he at this day discover, chase, and destroy the wild beasts of the field ? It is evident, that, to procure perfect safety, and to render himself master of the living universe, it would be necessary to begin by forming an union with those animals whom he found capable of attachment and obedience, to the intent of opposing them to the others. One of the first arts of man hath therefore been the education of the dog;

dog ; and the consequence of this art hath been, the peaceable possession of the earth.

Without the dog, man could ~~not~~ have dared pretend to such a conquest, because the greater part of animals have more agility, more swiftness, more strength, and even more courage than man. Nature hath better provided, and better armed them than him : they have sense also and the faculty of smelling in the most perfect degree. To have gained, therefore, a species of animal, courageous and docile as the dog, was to have acquired a new sense, and faculties which were wanting to us ; it was to have discovered great and eternal means of conquest ; it was, in one word, to have immortalised the sportsman and the art of the chase.

After having thus become the advocate of the dog, and so warmly recommended him to the favour of his master ; let not the false and affected friends of humanity be alarmed at the modes of discipline which are hereafter described, and even approved ; nor persuade themselves to think that they

are incompatible with the finer feelings, and unjustifiable on the principle of sport*. They are but means to prevent a greater evil; the natural faculties of the dog must be trained to their proper object and purpose; he is by nature wild and depredatory; he will sometimes return to his natural hankering; and we venture to pronounce that the *man of feeling* would, at the sight of sheep worried in the fold, and of pigs and poultry in the farm-yard, acknowledge the truth of the old adage, and follow its dictates, "of two evils to choose the least:" and were he either in the situation of the owner of the dog, or the sufferer by his actions, he would equally countenance the severities alluded to, and acknowledge them to be salutary modes for the correction and prevention of such vicious habits.

There is however one circumstance, relating to the economy of this animal and his dependance on man, which would honourably engage the feelings and the know-

* Vide Monthly Review for June 1790.

ledge of those capable, by professional education, to undertake the task ; we mean, an investigation of the various diseases to which dogs are subject (we say *various*, because we do not subscribe to that old but erroneous judgment which calls every disorder with which a dog is afflicted, by the general name of the *distemper*), and thereby to form a rational system of treatment. It is really surprising that no one has hitherto attempted this humane office ; to many we are convinced it might be extremely easy. The whimsicality and rage of the present hour furnish us with a variety of bombastic writers and treatises upon the means of *prevention*, as well as the method of *curing* diseases incidental to horses : it has also, in a lucky hour, given birth to a *society* or *college* of *Veterinarians*, instituted for the express purpose of improving the art of farriery, and to this end, soliciting communications from all the world, of any important information or useful discovery which may conduce to the improvement and extension of that branch of science. As a sports-

man, may we not be permitted to say, that the horse is not a more useful nor a more noble animal than the dog? For the sake of humanity, then, and for the enlarging of knowledge, we recommend and intreat this respectable and promising useful society to extend their plan, and to invite communication on the nature and cure of the diseases to which this worthy and affectionate creature is peculiarly subject, and subject, we are sorry to say, at this time, without any one rational mode of treatment for the alleviation of pain, or the removal of complaint. For him, a small space of time intervenes between the administration of the most violent improper and inapplicable remedies, and the more humane but still brutal one of the *rope*. Thus is a period barbarously put to his various miseries, and thus is he, to the last, *treated as a dog*.

We are persuaded that the diseases of dogs are generally produced by the little care taken of them, and this at least may be easily remedied.

But to return from this digression, which

we most sincerely hope will have the effect intended, to the matter of which we have professed to treat, we have once more to solicit the candour of our readers towards the instructions we shall lay down, again availing ourselves of our former allegation, that we do not in this part of the work write for *finished* sportsmen, but only for the *noviciate*. To the gentleman who may choose to train his own dog, we flatter ourselves the general modes hereafter described will be useful; the dog-breaker by profession can gain no new information from it; nor do we think that the former can, by the closest observation of them, attain to teach his dog such nicety and accuracy of *manège*, that he can pretend to vie with the dogs of those days when sportsmen shot their game* *set*, and when the dog was trained to be obedient to the almost imperceptible whisper, to the slightest motion of the hand, and comprehended every thing that was required of him without the need of a single

* Vide the Introduction.

word being spoken to him : at that time the dog was an agent absolutely necessary to the success of the sportsman. But, at present, when volant wings cannot save the birds from the mortal shot, and when quadrupeds can no longer ensure safety by the fleetness of their course, a dog with all this address is only a secondary consideration ; and the sportsman who is not very ambitious on the one hand, or very blood-thirsty on the other, may possibly be content with a pointer formed and educated under the rules we have presumed to lay down.

Three species of dogs are capable of receiving the proper instruction, and of being *trained*. These are, the smooth pointer, the spaniel, and the rough pointer. The last is a dog with long curled hair, and seems to be a mixed breed of the water-dog and the spaniel*. The smooth pointer is

* Spaniele, index, or the setter : they are called English spaniels ; whence it is probable, notwithstanding the derivation of the name, that they are natives of Great Britain. — The pointer is a dog of foreign extraction, and was unknown to our ancestors.

active, and lively enough in his range, but in general is proper only for an open country.

The greatest part of these dogs are afraid of water, brambles, and thickets ; but the spaniel and the rough pointer are easily taught to take the water, even in the coldest weather, and to range the woods, and rough places, as well as the plain. Greater dependence may therefore be had on these two last species of dogs, than on the smooth pointer.

Before you begin to break in a dog, it will be proper, when he is only five or six months old, to teach him to *fetch* and *carry*, which may easily be done without going out of the house, by means familiar to every one. With patience and gentle treatment, if the dog is of a good breed and disposition, he will acquire the habit very easily ; but much gentle usage is necessary at this time, and if the dog should be obstinate in learning his lessons, severity and correction should be carried only to a certain point. Therefore, as you perceive him to be disheartened,
let

let him rest, bestow careffes on him, and return to the task another time.

If, however, this task cannot be accomplished by mild treatment, you must wait until the dog is of a proper age to be regularly trained; for then, in case of great obstinacy, he will be able to bear the strong collar, and those other modes of discipline, which will be hereafter described.

It will, at the same time that you teach the dog to fetch and carry, also be proper to give him the first principles of obedience; which may be accomplished by walking with him a little distance from the house, and there learning him to come in, when he runs too far off; and to go behind when he returns; using in the first case the words, *here, come in*; and in the latter, *back, or behind*.

It is also highly necessary to accustom the dog, at this period, to be tied up in a kennel or stable, where you should be careful to renew his straw frequently.

But in these first essays, he should not be kept tied up too long, in consideration of his tender age, which seems to require some

indulgence; he should, therefore, be let loose in the morning, and fastened up again in the evening. Dogs which are not early accustomed to be chained up, disturb you with their howling.

It is also of importance, that the person who intends to train him, should alone speak to and command him, and that none other should interfere with his education, or give him his food.

When the dog has attained the age of ten or twelve months, it will be high time to carry him into the field, for the purpose of regular training. At the first you may let him do as he likes, without requiring any thing of him, the first step being only to make him know his game. He will, at this time, run after every thing that he sees; crows, pigeons, thrushes, small birds, partridges, hares. This eagerness being somewhat abated, he will end by only pursuing the partridge and hares, to the former of which his natural instinct will more particularly attach him; and being soon tired with following after these in vain, he will
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be content, after having flushed the birds, to follow them with his eyes.

He will not, however, do the same with hares; for seeing that they have but legs like himself, and do not leave the ground as partridge, he perceives that there is more equality with himself, and will not relinquish the hope of overtaking them: for this reason, he will continue the practice of running after hares, until corrected by education; and even then, it is very difficult to prevent the most crafty and best-trained dog, from pursuing hares.

All young dogs are subject to *rake*, that is, to hunt with their noses close to the ground; a habit, which you should not suffer them to contract, and of which you should effectually break them betimes, if it is possible to be done; for a dog that rakes with his nose, and follows the game by the track, will never make a good pointer, nor find half so much game, as one that hunts with his nose high. Whenever, therefore, you perceive that your young dog is following the track of partridge down wind,
call

call to him with an angry tone, *bold up*; he will then grow uneasy and agitated, going first on one side, and then on the other, until the wind brings him the scent of the birds. He will only have to find the game four or five times in this way, when he will take the wind of himself, and hunt with his nose high.

Yet, there are dogs which it is almost impossible to break of this fault, and such are scarcely worth the training. The best method to be used with a dog of that description is, to put the *puzzle peg* upon him. This is an instrument of a very simple construction, being no other than a piece of oak or deal inch board, one foot in length, and an inch and a half in breadth, tapering a little to one end; at the broader end are two holes, running longitudinally, through which the collar of the dog is put; and the whole is buckled round his neck; the piece of wood being projected beyond his nose, is then fastened with a piece of leather thong to his under jaw. By this means, the peg advancing seven or eight inches beyond his snout,

snout, the dog is prevented from putting his nose to the ground and raking.

This instrument is also proper for dogs that tear the game ; and sometimes has been found to make a dog that is too eager, and possessing the bad habit of running up to the foremost dog in the point, stand better in company.

Partridges lye much better to dogs which *wind* them, than to those that follow them by the track. The dog that winds the scent, approaches the birds by degrees, and that, more or less, as he finds them either shy or tame, or, in other words, whether they will lye well, which he is enabled to know by the scent which they emit, when they are uneasy ; and notwithstanding they see him hunt round about them, they will not be alarmed, because they do not perceive that he is following them.

Nothing disturbs the birds more than their seeing a dog tracing their footsteps, and keeping the same course that they are taking to steal off ; and when a dog follows them in this manner down wind,
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it most commonly happens that he flushes them; or if, by accident, he makes a point, it will probably be much too near the birds; for, in going down wind, he cannot take the scent until he is almost upon them, and then they will not lye.

As soon as the young dog knows his game, you must bring him under complete subjection and command. If he is naturally tractable, and has profited from the instructions you have given him, before his being taken into the field, it will be easy to accomplish it; but if he is stubborn and unruly, it will be necessary to make use of the *trass cord*.

This is done by only fastening to the collar of the dog, a rope or cord, of about twenty or twenty-five fathom in length, and then letting him range about with this dragging on the ground. By the help of this cord, you will be able to keep him in, whenever you call to him, which you should never do but when you are within reach of it; and then, if he should continue to run forward, you must check him smartly with the
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the cord, which will often bring him upon his haunches. When you have repeated this a few times, he will not fail to come in immediately on being called; you should then caress him, and give him a bit of bread, and continue to do so, whenever he comes in on being called to.

After this, in order to accustom him to cross and range before you, turn your back to him, and walk on the opposite side; when he loses sight of you, he will come to find you, he will be agitated and afraid of losing you, and will, in ranging, turn his head from time to time, to observe whereabouts you are. Eight days practice of this manœuvre, will make him range on whatsoever side you please, by only giving him a sign with the hand.

When the dog is arrived at this point of instruction, be careful to keep him constantly tied up; never unchain him but when you give him his food, and not always then, but at those times only, that he has done something to deserve it.

The next step will be to throw down a piece

piece of bread on the ground, at the same moment taking hold of the dog by the collar, calling out to him, "*take heed;*" "*softly.*" After having held him in this manner for some space of time, say to him, "*seize,*" "*lay hold.*" If he is impatient to lay hold of the piece of bread before the signal is given, correct him gently with a small whip. Repeat this lesson until he "*takes heed*" well, and no longer requires to be held fast to prevent him from laying hold of the bread. When he is well accustomed to this *manège*, turn the bread with a stick, holding it in the manner you do a fowling piece, and having done so, cry, "*seize.*"

Never suffer the dog to eat either in the house or field, without having first made him "*take heed*" in this manner.

Then, in order to apply this lesson to the game, fry small pieces of bread in hogs lard, with the dung of partridge; take these in a linen bag into the fields, stubbles, ploughed grounds, and pastures, and there put the pieces in several different places, marking the spots with little cleft pickets
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of wood, which will be rendered more distinguishable by putting pieces of card in the nicks. This being done, cast off the dog, and conduct him to these places, always hunting in the wind. After he has caught the scent of the bread, if he approaches too near, and seems eager to fall upon it, cry to him in a menacing tone, "*take heed*;" and if he does not stop immediately, correct him with the whip. He will soon comprehend what is required of him, and will stand.

At the next lesson, take your gun charged only with powder, walk gently round the piece of bread once or twice, and fire, instead of crying "*seize*." The next time of practising this lesson, walk round the bread four or five times, but in a greater circle than before, and continue to do this, until the dog is conquered of his impatience, and will stand without moving, until the signal is given him. When he keeps his point well, and stands steady in this lesson, you may carry him to the birds; if he runs in upon them, or barks
when

when they spring up, you must correct him ; and if he continues to do so, you must return to the fried bread : but this is seldom necessary.

There are many dogs that will point the first day they are taken out, and there are others which will both point and back the first time, by natural instinct. But to make the dog staunch, you should endeavour to kill a few birds on the ground before him, and should not shoot flying, until he is well trained, and steady. This, however, can only be done when the dog is broke in during the shooting season.

The spring is the best time for training dogs ; because the birds being then paired, lye better, and being sprung more seldom, and in fewer number, the dog is not so subject to be eager, and is kept under command with greater ease. But as this season scarcely allows time to make the dog perfect and staunch, you must resume his lessons in the month of September, or the latter end of August, which will soon complete him.

Another

Another method used to break in a dog, is, with a cord of the same length as the former, and the strong collar. This collar is made of a strong leather strap, and stuck with three rows of small nails, the points of which extend three or four lines of an inch beyond the surface of the inside; a strong piece of leather is then put over the heads of the nails, on the outside of the collar, in order to prevent their starting back, when the dog presses upon the points. A ring is fastened to each end of this collar, for if it was buckled like a common one, it would perpetually wound the dog; through these rings, therefore, is passed one end of the cord, in such a manner, that in pulling towards you, the rings bring the collar close; the nails then press upon his neck, and warn him of his fault.

As soon as the dog is instructed to "*take heed*" of the bread, in the way before explained; you must carry him into the fields, with the strong collar on his neck and the trash-cord dragging on the ground; be careful not to let him range too wide,

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but keep him within such a distance, that you can always lay hold of the cord, at those times, when it may be necessary to check him.

When the first birds are sprung to the dog, if he runs after them, or barks, give him a few checks, calling out to him, "*take heed.*" If he stands at them, then caress him ; but you should never hunt him without the cord, until he points staunch.

When once a dog is taught to point at partridges, he will stand at every sort of winged game, and even at hares ; yet as before remarked, it is very difficult to prevent dogs from running after hares, whether they start at a distance or after the dog has pointed them ; especially if he is at some distance from his master, who will, in that case, try in vain to make him come in ; for, when a dog perceives his master a good way off, he will not so readily obey his voice, as when he is near him. It is not easy to correct dogs of this fault (if it may be accounted such), except in places where there are many hares, for
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there, by seeing them frequently, he gets tired of pursuing them. Besides, to keep a dog in the habit of not running after hares, he must be hunted only in open grounds; for, if you once carry him into a wood, he will be certain to run after both hares and rabbits, and then when you return to the open fields, he will do as he did in the wood.

There are few dogs that will not sometimes break in upon the birds, particularly when hunting down wind; you should therefore, when he does so, only speak roughly to him, and not chastise him, unless, indeed, he runs after the birds; in that case, mark the place from which they got up, for the dog will soon return thither, and then you must chastise him with the whip; but with moderation, which is always necessary, and particularly so, if the dog is timid.

There are dogs of this nature, which, if you beat them excessively, will lye down at your feet, and will hunt no more: others again leave you and run home. In the

last case, one mode of correction is, to have a stake fixed in the middle of the yard, furnished with a chain and collar ; when the dog arrives, a servant previously instructed, should fasten him to the stake, and give him a sound beating, which should be repeated at intervals, for the space of an hour. During this operation, the master should not appear, but remain without shewing himself, until some time after the last correction, in order that the anger of the dog may have time to subside. Then he should go up to him, caress him much, unchain him, give him some food, and afterwards carry him back to the field. However, this mode is not so infallible as many have asserted ; for it often happens, that the dog who has thus received the strappadoes, the next time he arrives at the house, after having run away, slinks off, and lurks in some hole, without your knowing what is become of him, and does not make his appearance again for a long while.

The best way is, to study the temper and disposition of the dog, and to conduct yourself

self accordingly in the application of correction.

We have before said, that when you cannot succeed in teaching a dog his first lessons at an early age, by gentle treatment, it is necessary to wait until he is older, and then to make use of the strong collar; here then is the best mode of using it. Take a square piece of wood, of about eight or nine inches in length, and one inch in thickness, cut notches on the edges like the teeth of a saw, and bore two holes at each end, in order to fix two small pegs cross-wise, so that when this piece of wood is thrown on the ground, the pegs may support and raise it above the surface a full inch, the purpose of which is, to enable the dog to mouth it the more easily. The strong collar should then be put about his neck, and taking the stick, rub the notches backwards and forwards on his teeth, to make him open his mouth; but do it gently, to hurt him as little as possible: when he has taken it into his mouth, hold your left hand under his chaps, in order to prevent his putting it out, and with the right

cares and pat him, crying "*take heed.*" If, when you take away your hand from under his mouth, the dog lets fall the stick, speak harshly to him; and check the collar to chastise him; then make him take the stick in the same manner as before. The dog thus perceiving that he is punished when he drops the stick, and caressed when he retains it, will at length accustom himself to hold it, and will open his mouth when you present it to him. You must then proceed to make him take it himself, by presenting it to him, crying at that instant, "*lay hold;*" at the same time, you should caress him much, and now and then give him little checks, to make him more alert, and come forward more expeditiously.

If, in practising this lesson, the dog advances of his own accord, and takes the stick, caress him again, and give him a little bit of food. When he begins to put forward his head an inch or so, he is then sufficiently broken in to this manœuvre, and will soon take the stick from the ground, in doing which you must first say to him very loud,
"*lay*"

"*lay hold,*" and afterwards, "*bring here.*"

In order to habituate the dog in this exercise, when he is advanced so far as to bring the stick readily, you should sometimes substitute in the place of the piece of wood, the wing of a partridge, sewed upon a linen cushion, and at other times the skin of a hare stuffed with hay, in each end of which you should put a stone, to accustom him to carry a hare by the middle of the body. At length when he brings every thing readily to you, carry him into the field, and make him bring the first bird that you kill to you ; if he requires much entreaty, put the strong collar on him, which, in case of need, you should carry along with you.

To teach the dog to take the water, choose a pool, the edges of which gently decline ; throw a piece of wood into it, at first but to so small a distance from the side, that he may be able to reach it by only wading to his mid-leg. Afterwards increase the distance by degrees, until he swims to take it ; be careful at each time that he brings

the piece of wood to you, to give him something to eat. If he will not venture to swim, you must take another course; carry him to the pool before he has breakfasted, and throw pieces of bread into the water, gradually increasing the distance as before, and by this method, you will soon teach him to earn his breakfast by swimming.

To complete this training, if you have a piece of water of sufficient depth, put a wild-duck into it with the wings cut, then animate and encourage the dog, until he goes into the water to follow the duck, which will swim before him, and sometimes dive when followed close, in order to disengage herself from the pursuit. When this *manège* has lasted some time, finish it by shooting the duck, and the dog will not fail to bring it to you very readily. These lessons, however, should be given in warm weather, for you will scarcely prevail on any dog to go into the water in winter; even the attempt alone might give him a dread

dread of it ; but at all events, if he refuses to take the water, you should never throw him in.

The sportsman has only to conduct himself with patience and moderation, and observe the rules here laid down, and he will accomplish his work.

To make a dog *back*, and stand in company, you should hunt him with an old staunch dog ; and then, with a small application of the principles of training, you will easily effect this necessary qualification.

Young dogs, for the most part, love to run after poultry, and some after sheep ; these are faults which it is absolutely necessary to correct betimes. As to the poultry, if you cannot make your dog leave off the custom of chasing them, by the virtue of the whip, the following method will do it. Take a small stick, cleft at one end sufficiently wide to admit the tail of the dog, which being introduced, tie the cleft end with a piece of twine tight enough to make him feel pain ; at the other end of the stick tie a fowl by the wing ; then after a little

4
time,

time, let the dog loose, at the same instant giving him a few heavy strokes with a whip. The dog will then run as fast as he can, by reason of the pain in his tail, which he imagines is caused by the fowl. By dint of dragging the fowl, he will kill it, and, spent with running, he will stop, and afterwards hide himself in some hole; then take off the stick, and beat him about the mouth and head with the dead fowl.

If the dog runs after sheep, and you cannot break him of the custom, couple him with a ram, and in letting them loose, whip the dog as long as you can follow him. His cries will at first alarm the ram, who will run with all his speed, and drag the dog along with him; but he will soon take courage, and will end with butting the dog most severely. When you think the dog has received sufficient correction, uncouple him, and he will never run at sheep again.

C H A P. XVII.

The Game.

THAT the present work may be of general utility, we will, in the last place, proceed to treat, though not diffusely, of the various species of game, and of a few of those other birds and animals, which afford the diversion of shooting in England. And, that the subject may be productive of entertainment, as well as instruction to the sportsman, we will also add descriptions of some few particular methods of approaching those objects of sport; not such as are in general knowledge and practice, but those only, which from their singularity, as well as excellence, are worthy of note; avoiding any account of those various devices that man has invented to deceive the continual vigilance which animals in a state of nature

oppose to his snares, and which, in the present refined state of sporting, are wholly confined to the practice of a set of gentlemen denominated *poachers*.

THE HARE

IS of all the animals hunted with hounds, that which best defends itself by the exercise of cunning. The chase also of this little creature, is not only less expensive, but more interesting and agreeable than any other.

Without making mention of her ordinary shifts, such as getting up into the hollow stump of a tree, or upon the walls of an old ruin, we will just observe, that the hare has been known, after having made several doubles, to squat down until the dogs and horsemen have passed by, then to take the back scent, and return upon that track which the hounds have pursued.

Another has been known, after doubling
many

many times in a marsh near the edge of a river, to throw herself into the water, float down with the stream the length of 500 paces, and then to get upon a little island.

A third has been known to swim into the middle of a piece of standing water, keeping only her nose above the surface in order to draw breath *.

These are matchless efforts of cunning.

According to naturalists, the hare lives six or seven years, and attains its full growth in one. From the first year it engenders at all seasons, and has no particular time for coupling with the female. Yet, it is observable, that from the month of December to the month of March, the buck seeks the doe more frequently, and about that time the greatest number of leverets are found. The doe goes with young thirty, or one-and-thirty days, and brings forth one, two, three, and sometimes four young ones,

* The doubling of the hare, before she goes to her form, thereby to dodge and deceive the dogs, is a remarkable instance of the natural sagacity of this animal for purposes of her security.

which

which she kindles in a tuft of grass or heath, or in a little bush, without any preparation whatever.

When there are several leverets at a birth, it is said that the whole are invariably marked with a star on the forehead, and when there is but one, it is also said that it never has this mark.

Several authors of natural history have asserted, that all, or the greatest part of hares, were hermaphrodites. We are astonished to find it advanced in one book (amongst many others), which treats of modern sport *, "*That the male hare engenders in its own body, but never brings forth but one leveret.*"

It is remarkable also, that the ancient *Leges Wallicæ* affixed no fine for the killing of a hare, for this singular reason, that it was believed every other month to change its sex.

The circumstance which seems to have given rise to this strange conjecture, is the

* Nouveau Traité de Venerie par Clement de Chapville, Paris, 1742.

formation of the genital parts of the male hare, whose testicles do not appear on the outside of the body, especially when he is young, being contained in the same cover with the intestines. Another reason is, that on the side of the penis, which is scarcely to be distinguished, there is an oblong and deep slit, the orifice of which much resembles the *vulva* of the female. This equivocal conformation makes it difficult to know the sex of hares by the inspection of the genital parts; sportsmen therefore seldom refer thither in order to distinguish the male and female, but resort to other marks, which point them out more easily. Thus the head of the male is more short and round, the whiskers longer, the shoulders more ruddy, and the ears shorter and broader, than those of the female; the head of which is long and narrow, the ears long and sharp at the tip, the fur of the back of a grey colour inclining to black, and, in point of size, is larger than the male.

The male hare, or buck, when he is hunted with hounds, after making one or
two

two rings, generally runs straight forward; he goes a great way, and makes a long chase. The doe runs less, she dodges about the place she inhabits, and more frequently doubles.

When a hare is espied on the form, if the manner in which the ears lie, is observed, it may be known whether it is a buck or doe. If a buck, the ears will be drawn close upon the shoulders, one against the other; but if a doe, the ears will be open and distended on each side of the neck and shoulders.

Two species of hares may be distinguished; those of the wood, and those of the plain.

The hares of the wood are, in general, much larger than those of the open ground, their fur is not of so dark a colour, and they are better covered with it; they are also swifter in the chase, and their flesh is of a better flavour.

Among the hares of the plain, those may be distinguished which inhabit the marshes. They are not so swift of foot, they are less covered

covered with fur, and their flesh is not so fine and delicate.

A young hare that has attained the full growth, is known from an old one, by feeling the knee-joints of the fore-legs with the thumb-nail. When the heads of the two bones which form the joints, are so contiguous, that little or no space is to be perceived between them, the hare is old. If, on the contrary, there is a perceptible separation between the two bones, the hare is young, and is more or less so, as the two bones are more or less separated. It may also be known whether a hare is young or old, but without pretending to ascertain the precise age, by compressing the under jaws: if they break at the point immediately under the fore teeth upon a slight degree of pressure, the hare is certainly a young one; but if considerable force is required, the contrary is as certain.

But as shooting, or otherwise destroying hares, although an amusement much admired by the sportsmen of other kingdoms, yet in this is practised only by poachers,

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and

and is even doubted by some to be permitted by the existing game-laws; we will purposely omit all description on that head, and content ourselves with giving one hint on the subject.

If the sportsman wants to come near a hare which he has espied upon the form, he must not go towards her in a straight line, but approach circularly, otherwise she will start up.

As the reason for omitting a detail of the methods practised for approaching hares, in order to shoot them, does not extend to rabbits, our information regarding them shall be more extensive.

THE RABBIT.

EVERY one knows the prodigious fecundity of this animal, particularly of the tame ones, the females of which bring forth almost every month in the year. Among those of the warren, of which alone we
speak

Speak here, the doe brings forth only five or six times in the year, each litter consisting of four, five, and sometimes seven young ones. When she is about to kindle, she scratches, in the burrow she inhabits, a smaller one, of only two or three feet in depth, for the purpose of keeping from the buck the knowledge of her young ones, fearing that he would kill them*. She frequently kindles at a considerable distance from her own burrow, and sometimes out of the warren, in the open country. At the bottom of this excavation, which by warreners is called the *rabbit's nest*, she prepares a bed for her young, composed of the fur which she pulls from her belly, and a few blades of grass. Here she suckles and attends them, for the space of six weeks. It is pretended, that, whenever she goes out

* The male rabbit has the same unnatural dislike to its offspring as the Arctic black bear and some other animals have, they will kill the young ones; the female therefore retires before the time of parturition into some secret place, to elude the search of her savage mate.

PENNANT.

of her nest to procure food, she, in order to preserve her young from the depredations of vermin, stops up the mouth of the hole with earth diluted with her own urine.

At the expiration of six weeks, she conducts her young ones to the great burrow, for in this time they are in no danger from the male, who then caresses them, takes them between his fore feet, and licks their fur smooth with his tongue.

An old rabbit is distinguished from a young one by the same signs which we have before described in speaking of the hare.

No sport is more pleasant and easy than that of hunting rabbits with one or two terriers, in a warren which is tolerably well stocked; especially, if the terriers are wry legged. For, in that case, the rabbits only play before the dogs, stopping at each instant to listen to them, and suffering themselves to be driven about sometimes for the space of three quarters of an hour before they take the burrow. Then as these ani-

mals run about in a small compass, it is very easy to come in their way, either in the passes, or the sides of the woods, by following the cry of the dogs; or else by waiting for them at the burrows, about which they generally play for some space of time, before they take the earth.

The rabbit is very timid, and very acute of hearing; for which reason, care should be taken to make as little noise as possible; and in particular, never to walk or run in the passes or across the woods to get before them, but at those times only when the dogs give tongue; for then the rabbit, being occupied either with listening to the dogs or running before them, pays less regard to the noise which the sportsman makes in the pursuit.

In a warren of small extent, much amusement may be procured by stopping up all the burrows at midnight, at which time the rabbits are almost all out at feed, and then going to hunt them the next morning; by thus cutting off their retreat, a man cannot

fail to kill several. Or, he may stop up the burrows with hay, grass, or any other material, at the distance of two feet from the mouth downwards, and then when the rabbits are driven in with the dogs, he may take as many as he pleases.

Rabbits are hunted with dogs, at all times of the year; but the months of July and August are the most favourable; they then abound, and are of a good size; some have attained their full growth, and the smallest are half grown; earlier than this they are scarcely worth the trouble of shooting, and the dogs hunt them badly, because they do nothing but dodge about little bushes, not being in a condition to defend themselves.

Skill and practice, but above all quickness, are eminently necessary to shoot rabbits in a wood, either when the rabbit is hard run by the dogs, or at the moment of starting up, or in a view; and still more so, when pursued by a spaniel who has struck at but missed her. If at this time
the

the rabbit crosses a road, or a pass cut through a wood, she darts like lightning, and scarcely gives the shooter time to prepare himself, unless the way is very broad.

It is also very difficult to shoot her when she gets up from among his feet, whether in a wood, or in places covered with heath or brambles which adjoin the warren, and where they are most commonly found. The course of a rabbit for some little time at the first, is much more rapid than that of the hare, and is at the same time oblique and twisting. It seems to glide rather than run, and the proper moment of shooting is not easily seized.

There are many other ways of killing rabbits, of which lurching is in most common use. This succeeds best in fine weather, and at those times when the young rabbits are in abundance.

If at any time of the day, but principally from nine in the morning until noon, and again in the evening, about sunset, the sportsman posts himself near some well-frequented burrows, either by getting up

into a tree, or lying behind a hedge, he will soon see them come out of their holes and play about the edges, at which time he may shoot them to great advantage. Or he may in the evening watch those pieces of corn-land which lye near the warren; for thither the rabbits are certain to go at that time to feed.

Rabbits, being accustomed to run about much during the night, may be shot by moonlight, by watching at those places where they come to play or feed.

Or a ferret may be put into the burrows, and the rabbits shot as they bolt out; but this is so rapid a motion that great quickness of shot will be necessary.

P A R T R I D G E

PAIR in the spring, but at an earlier or later period, in proportion as the season is more or less mild. When the weather is egisal in the month of January they are found

found in pairs, but then, if the cold weather returns, they again form in coveys.

The hen partridge lays her eggs during the whole of the month of May, and the beginning of June. Her nest is made upon the ground, and consists only of a few blades of grass, constructed without art, either at the edge of a corn-field, in a meadow, a heath, &c. She lays from fifteen to twenty eggs.

The earliest birds begin to fly towards the latter end of June. From this state of growth their plumage undergoes a variety of changes, until the period arrives when the red and blackish feathers begin to form the *horse-shoe* upon the breast, which is very conspicuous on the male, but less distinguishable on the female: this mark takes place about the beginning of October, and it is not until that is perfect that they can properly be called *partridges*.

The young birds at this time, when the plumage is complete, can only be distinguished from the old ones by the first feather of the wing, which terminates in a
point

point like a lancet, whereas in those which are not of the last brood, this feather is round at the extremity.

This distinction remains until the first moulting, which generally takes place in the July following. A further difference is also observable in the colour of the legs, which in the young ones are yellow, and in the old grey.

The difference between the male and the female, when the partridge have attained their full growth, consists in the horse-shoe, which we have before noticed, and in an obtuse spur on the hinder part of the leg; the male only has this protuberance, and he is besides a little larger than the female.

Partridge are not equally abundant every year; their number depends in a great measure upon the mildness of the weather, not only at the time of laying the eggs, and the season of incubation, but also, when the birds are hatched: this period of time is, for the most part, from the end of April, to the middle of June.

In general, when the season is dry at this period,

period, the birds are very numerous. But on the contrary, when the rains have been heavy and frequent during the time of laying and incubation, the nest, which the partridge prefers to make in low places, is destroyed by the floods; an event which would not probably have happened, if the rains had set in sooner; for in that case, the partridge finding the plains and low places too wet, would have chosen to build her nest in a dry elevated situation. If the rains happen at the time when the young birds come out of the shell, many of them, which have scarcely strength at that time to stand, will be drowned. A wet season also destroys the ants, which are the chief food both of young partridges and pheasants. At such time even drought, when it is in a certain degree, is unfavourable to them, for then the ground cracks, and forms crevices, into which they fall and perish; being too weak to extricate themselves.

The old partridge has also many dangers to encounter, from the time of laying her eggs until the young ones are hatched;
and

and these arise as well from weazels and other vermin, crows, magpies, and shepherds dogs (all of which suck the eggs), as from the shepherds and farmers themselves, who destroy the eggs. So that, except in those manors which are well preserved, there is reason to suppose, that one half of the broods in any one year, are never reared.

When the eggs of a partridge are destroyed in any of these ways, it sometimes happens that she lays again; therefore, when at the end of September, and even later than that, young birds are found not perfectly feathered in the tail, they are of this second hatching, or as it is sometimes termed "*clacking*."

Whilst the birds are young, that is to say, until the middle of October, it is easy to shoot them, in a country tolerably well stocked; but after that period, and especially when they have tasted the green wheat, they fly far and are very wild; they are not to be separated but by dint of following them down, particularly in a flat country, where there are neither roughs nor thickets;

thickets ; and it is only by breaking the covey that we can indulge a reasonable hope of success ; for while they remain in the covey, we can scarcely get within gunshot of them. Thus, it is more essential in this sport, than in any other, that the shooter should have good legs and eyes : the legs, to tire the birds and break the covey, by an incessant pursuit ; and the eyes, to mark them down with certainty.

When a sportsman is shooting in a country where the birds are thin, and he no longer chooses to range the field, for the bare chance of meeting with them ; the following method will shew him where to find them on another day. In the evening, from sun-set to night-fall, he should post himself in a field, at the foot of a tree or a bush, and there wait until the partridge begin to call or "*juck*," which they always do at that time ; not only for the purpose of drawing together when separated, but also, when the birds composing the covey are not dispersed. After calling in this manner for some little space of time, the partridge will take a flight ; then, if he
marks

marks the place where they alight, he may be assured they will lye there the whole night, unless disturbed. Let him return to the same post the next morning by break of day, and there watch a while; being careful to keep his dog in a string, if he is not under perfect command.

As soon as the dawn begins to peep, the partridge will begin to call, and soon afterwards will perform the same manœuvre as on the preceding evening; that is to say, after having called a while, they will take their flight, and will most commonly settle at a little distance. There, in a few minutes they will call again, and sometimes take a second flight, but that will be to no great distance. Then, as soon as the sun is risen, and the sportsman can see to shoot, he may cast off his dog and pursue them.

In snow it is very easy to kill partridge on the ground before a setting-dog or pointer; because the colour of the birds, contrasting with the whiteness of the snow, makes them perceivable at the first glance. Then the poachers have fine sport, especially

cially if the snow happens at the full of the moon. At this time they will be out the whole of the night, with shirts over their clothes, and white caps on their heads; and then, as the partridge lye in a cluster, they frequently destroy half the covey at one shot. Thus, snow may be accounted the most fatal time for partridge; for if it lasts but a little while, they are exposed to the wiles of the poacher, and if for a long time, they perish with hunger.

As one-third more of male than female partridges are bred in a season, it happens, that in the time of pairing, several cocks contend for the same hen, who being thus tormented, will sometimes totally desert the district; or if she remains, being thus obliged to run continually about, in order to avoid the pursuit of the males, whom she hath repulsed, she drops an egg in one place, and an egg in another, until, at length, there remains for her but one cock, and no nest.

It would therefore much increase the broods of partridge, to kill a part of the
cocks

cocks when they begin to pair ; but as this could only effectually be done after the time limited for shooting them in this country expires, we must necessarily omit giving any instructions on the subject. There are, however, some few sportsmen in England, of such keen eyes, that they can distinguish the cocks from the hens, when the covey rises from the ground, and so expert, as to make it the pride of their dexterity, to kill not more than a brace of hens in one day's sport.

THE PHEASANT

IS of the size of a common dunghill cock. He is a superb bird, and, as Buffon says, may dispute the prize of beauty with the peacock himself, having a carriage as noble, a gait as proud and stately, and a plumage nearly as much distinguished. This of course is only to be understood as relating to the male, for the plumage of the hen has little splendour, and much resembles the quail,

quail, which makes them easy to be distinguished in shooting, and prevents the killing a hen instead of a cock.

These birds generally lay their eggs in the woods, the number of which is commonly ten or twelve. The season of the young pheasants, nearly corresponds with that of the partridge.

The pheasants of the first year are marked in the wing like partridge. The young cock, whose plumage is completed the first year, is in like manner known by the spurs, which in him are round and blunt, but long and sharp in the old one. The hen has also a small spur on the hinder part of the leg, which is very small in those that are young, and larger and more prominent in the old; but this happens in a greater or less degree, in proportion to the age of the bird. Besides, in the young ones, the spurs are surrounded each with a small black circle, which does not disappear until the second hatching.

The legs of those which are very old, that is to say, such as have attained five or

six years, are more wrinkled, and of a darker colour than those of the young ones in the first year; the crystal of the eye of the former is also more yellow, whilst that of the young ones of the first and second year is white. But all these marks and signs are not without many exceptions. The least equivocal mark, perhaps, is the beak, which feels more tender in the young than in the old birds.

Pheasants are accounted stupid birds; for when they are surpris'd, they will frequently squat down like a rabbit, supposing themselves to be in safety as soon as their heads are concealed, and in this way they will sometimes suffer themselves to be killed with a stick. They love low and moist places, and willingly haunt the edges of those pools which are found in woods, as well as the high grass of marshes that are near at hand; and, above all, places where there are clumps of alders.

The instinct of these birds is not of a nature so social, as that of the partridge. As soon as they find that they have no
further

further occasion for the care of the hen-mother, they separate from her, and live in solitude ; shunning one another at all times, except in the months of March and April, the season at which the male seeks the female.

During the day-time, pheasants remain upon the ground among the underwood, from whence they frequently issue forth into the stubbles, and the fields lately sown ; but it is only in countries where they are in great plenty, that they thus shew themselves in the open grounds. At sun-set, the greatest part of them fly up into the long branches of oak trees, in order to roost all night, and at the time they do this, they invariably make a noise, which is called "*cocketing*," and that in a greater degree during the winter season ; so that poachers who lye in wait for them in the evening, are warned by the noise of the place where they are perched, and, when the night is advanced, repair under those trees which the birds have chosen, and there shoot them with the greatest ease ; for at this time the pheasants

will permit them to come as near as they please, and will sometimes even permit the poacher to fire more than one shot, before they will leave the tree.

The pheasant is also frequently taken when thus perched upon a tree, by holding a lighted match directly under him, so that, the fumes of the sulphur reaching him, he falls suffocated to the ground *.

THE GROUSE, OR MUIR- GAME,

ARE found in some parts of the northern counties of England, and in parts of Wales; but in neither of these countries are they at this day very numerous.

* Monf. du Pratz in North America hit upon a very ingenious expedient for taking the passenger pigeon on the roost, by placing under the trees vessels filled with flaming sulphur; the fumes of which ascending, brought them senseless to the ground in perfect showers.

PEN. ARC. Zool.

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In Scotland, however, and particularly in the vicinity of the Grampian mountains, they abound in such sort, that a tolerable shot may kill from twenty to thirty brace a day, for the first three weeks of the season; provided the weather is favourable. An excursion, therefore, into that country in the grouse season, affords the keen sportsman a noble entertainment.

This species of sport is so perfectly similar, in all its operations, to that of partridge shooting, that it will be unnecessary for us to say more on the subject, other than to subjoin a short description of the bird, and some of its habits.

The grouse is larger than the partridge, and weighs about nineteen ounces. The plumage is a mixture of red, black, and white, and the tail is nearly similar to that of the partridge, only a little larger. The legs are clothed with feathers to the very toes, and the outmost and inner toes are connected to the first joint of the middle toe by a small membrane. The bill is short, arched, and of a blackish colour, and the
 U 3 eyes

eyes are encircled with two large and red eyebrows, which are composed of a fleshy membrane, rounded and pinked on the upper part, and extending beyond the crown of the head.

The plumage of the hen has less of the red and more of the white than the cock, the membrane of the eyebrow is less projected, less pinked, and of a less lively red. She makes her nest on the ground, and lays from eight to ten eggs.

The principal food of grouse is the black whortle berry (*vaccinium myrtillus*) and the red whortle berry (*vaccinium vitis-idaea*), also common heath berries. It is a custom in Wales, to cut open the part which contains the food, for young sportsmen to smell—the fragrance is accounted extremely fine.

The young birds for the first year are called "*Poults*."

The grouse inhabit those mountains and moors which are covered with heath or "*heather*," and seldom or ever descend into the lower grounds. They fly in packs, consisting in general of four or five brace; and they love to frequent mossy
I places,

places, particularly in the middle of the day, and when the weather is warm.

The old cock is known by the "*chocking*" noise he makes; and when the dogs point at a brood, he is commonly the first bird that goes off.

In pursuing this game, if, when the dogs are set, the shooter perceives the birds to erect their heads and run, he may be pretty certain they will not lye very well during the course of that day; and the only mode by which he will be enabled to get a shot at them, is, to run after them as fast as he can, the moment that he perceives their heads, and, by this means, he will probably get near enough to shoot when they rise upon the wing: this is found, by experience, to be the best method on those days, when the birds, either from wet, or some other cause, will not lye well to the dogs.

As the season for shooting this game commences in hot weather, and the birds, when shot, are subject to grow putrid in a short space of time, it is highly proper, especially if they are wanted to be sent to a distance,

that they be drawn carefully and extremely clean the very instant they are shot, and immediately afterwards stuffed with dry heather; and if the plumage happens to be wetted, by the fall to the ground, when the bird is shot, or by the tearing of the dogs, it must at the same time be wiped as dry as possible, before it is put into the game-bag. Before the birds are packed up to be sent off, it is also proper to lay them within the moderate influence of a fire, for some minutes, in order to render them more perfectly dry.

THE WOODCOCK

IS a bird of passage, and commonly arrives in this country about the latter end of October.

This passage, in different seasons, is more or less advanced or retarded, according as the wind and the weather happen to be, at the beginning of the autumn. The east and north-

north-east winds, and especially when they are accompanied with fogs, bring them over in the greatest numbers.

At their arrival on the first flight, they drop any where, as well under high trees, as in copses, in hedge-rows, among heath and brambles; afterwards they take up their abode in copses of nine or ten years growth, and sometimes in those little shaws, which, having been cut, are left to grow for timber; for it is but seldom that a woodcock is found in a young copse of more than three or four years growth.

When we say they take up their abode, we must not be understood to mean, that they remain in the same wood during the whole of the winter; for it is observed, that they do not stay longer than twelve or fifteen days in one place; and that, if they do remain there for a longer space of time, it is in consequence of some wound or hurt received.

This bird rises heavily from the ground, and makes a considerable noise with his wings. When he is found in an open field, in a hedge-row, or in the pass of a wood, he

he frequently only skims the ground, and then, his flight not being rapid, he is easily shot. But when he is sprung in a tall wood, where he is obliged to clear the tops of the trees before he can take a horizontal flight, he sometimes rises very high, and with great rapidity; in this case it is difficult to seize the moment of shooting, by reason of the turnings and twistings which he is obliged to make, in order to pass between the trees.

The woodcock walks very clumsily, as all birds are observed to do, which have great wings and short legs. His sight also is very bad, and particularly in the day-time. It is said, however, that he sees better in the dusk.

Shooting woodcocks, is a very pleasant amusement in woods which are not too thick; and if they are cut through in several places, it renders it more easy to shoot him in his passage when he springs in the wood, and also to mark him with greater certainty. Besides, this sport is more delightful and animating, as requiring a great noise and clamour with men and dogs.

There is a species of spaniels which give
tongue

tongue when the cock springs, or when they get upon his haunt ; these dogs are extremely useful, as they warn the sportsman to be upon his guard.

Pointers, in general, stand at the cock, which is oftentimes very inconvenient ; because it cannot be known what is become of the dogs, or whereabouts they are ; and as they will not come away when they are set, on being called or whistled to, the shooter has frequently to wait for them until his patience is exhausted. To obviate this inconvenience in shooting cocks with pointers, some sportsmen fasten a small bell about the neck or the tail of each dog, by the sound of which he may be followed in the wood ; and when the sound ceases, the shooter knows that the dog is on a point, and is thereby enabled to guess the place where the dog is.

In this sport, it is very material to have a good marker. With this assistance, if the wood is small, it will be difficult for a cock to escape ; for it is known, that he will frequently suffer himself to be sprung, and
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even shot at four or five times, before he will leave the wood to go to an adjoining one, or to a hedge-row.

During the day-time, the woodcock remains in those parts of the woods where there are void spaces, or glades, picking up earth-worms and grubs from amongst the fallen leaves. When night comes on, he goes to drink, and wash his bill, at the pools and springs; after which, he gains the open fields and meadows, where he abides during the remainder of the night, and at break of day he returns to the wood.

The sportsman may therefore advantageously watch at some opening, or cut which runs through the wood, and shoot him in his passage to and from it in the morning or evening flight; for it is remarkable, that whenever a woodcock springs from a wood to go into the open country, he always endeavours to find some pass or glade, which he follows to its opening out of the wood; and when he returns back to the wood, he in like manner pursues a way for some time, and then turns to the right
or

or left, opposite some glade, in order to drop in the thick part of the cover, where he may be under shelter from the wind.

It is in these openings that nets are spread to take the woodcocks, in their morning and evening flights.

They may also be watched with advantage in the morning and evening flights, at those narrow passes and little valleys on the edges of woods, which by their direction lead to some pool, spring, or head of a lake.

Those who know the custom which the woodcock has in the evening, of washing his bill in the pools which adjoin the woods, practise another method of killing them; which is, by watching near those pools in the dusk of the evening, in order to shoot them as they alight.

The pools or springs, which are most frequented in this manner, are always known to the neighbouring peasants; and it is easy to discover them on examination, by the marks of their feet on the margins.

Woodcocks remain in this country until the middle of March, and may be found
all

all the winter season, if the weather is not too severe. But if frosts happen which last for some time, they will almost totally disappear at that interval, and a few only will be found by hazard, in certain places, where there are warm springs which do not freeze.

A month, or thereabouts, before their departure, it is common to see them in pairs at the morning and evening flights, and to hear them, when flying, make a small piping noise, although, at other times, they are quite mute.

Since they are found in greater numbers in the month of March, than in the middle of winter, it is probable that they assemble at that time in order to go abroad.

Both woodcocks and quails have been known to breed in the southern parts of this kingdom; but the instances are very rare.

Woodcocks are fattest in the months of December and January; but from the end of February, when they begin to pair, to the time of their departure, they are much leaner.

Pennant

Pennant, in the Supplement to his Arctic Zoology, informs us, that the female woodcock may be distinguished from the male by a narrow stripe of white along the lower part of the exterior web of the outmost feather of the wing. The same part, in the outmost feather of the male, is elegantly and regularly spotted with black and reddish white. In the bastard wing of each sex is a small pointed narrow feather, very elastic, and much sought after by painters as a pencil.

S N I P E S

MAKE their appearance here in autumn, and remain until the spring. It is generally supposed, that they return into Germany and Switzerland to breed. Nevertheless, a great number remain with us during the summer, and breed in the marshes, where they lay their eggs in the month of June, to the number of four or five. Snipes are scarcely worth shooting until the first frost sets in; and in the month of November, they begin to grow very fat.

These

These little birds, when they abound, afford very excellent sport.

It is remarked, that snipes always fly against the wind, which is also the case with woodcocks; for this reason, it is best to hunt for them as much as possible with the wind to the back, because then they fly towards the sportsman, and present a fairer mark.

The snipe is generally esteemed difficult to shoot, by reason of the many turnings and twistings which it makes on being sprung: but this difficulty exists only in the minds of inexperienced sportsmen; for there are many birds more difficult to shoot flying. When once the shooter can accustom himself to let the snipe fly away, without his being in haste or alarmed, he will find that the flight is not more difficult to follow, than that of the quail; and it is better to let him fly to some distance, because the smallest grain of shot will kill him, and he will fall to the ground if struck ever so slightly.

Among the common snipes, some are larger than others. These are thought to
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be the males. Snipes, however, are sometimes found, which, from their extraordinary size, must necessarily be of a different species; but these are so rare, that they do not here require a particular description.

WILD DUCKS.

THIS race of birds, if we include all those which have the shape and conformation of the duck, is extremely numerous, and there is no other bird which affords so many different species as this. But as of these, only the common wild ducks are found in considerable numbers in England, we will confine our description to them alone.

Wild ducks also are birds of passage, and arrive here in great flights from the northern countries, in the beginning of winter. Still, however, a great many remain in our marshes and fens, during the whole year, and there breed. They pair in spring, and lay from ten to fifteen eggs.

The duck commonly constructs her nest

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at

at the edge of the water, upon some tuft of rushes which is a little elevated, and begins to lay in March or April ; her incubation is about thirty days, and the young ones are most commonly hatched in May.

The growth of their wings is very slow, and they attain more than half their size, before they are able to fly, which happens about the beginning of August, and near three months after the time of their being hatched.

The wild duck differs little in plumage from the tame duck, but is easily distinguished by its size, which is less ; by the neck, which is more slender ; by the foot, which is smaller ; by the nails, which are more black ; and above all, by the web of the foot, which is much finer and softer to the touch.

The young ducks of the first year, are distinguished from the old ones, by the feet, which are more soft and sleek, and of a brighter red. They may also be known by plucking a feather from the wing ; for if the duck is young, the root or end of the quill will be soft and bloody ; if old, this

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extremity will be hard, without containing any bloody matter.

In the summer season, when it is known that a team of young ducks are in a particular piece of water, and just beginning to fly, the sportsman is sure to find them early in the morning, dabbling at the edges of the pool, and amongst the long grass, and then he may get very near to them : it is usual also to find them in those places at noon.

By means of a little boat, they may be shot at any time of the day, and this method succeeds admirably well on small pieces of water ; for with the help of it they may all be killed. It will be still more easy to effect this, if the sportsman can contrive to kill the old duck ; in that case, he may tie a tame duck by the leg with a piece of packthread to a pin of wood drove into the ground at the edge of the pool ; this must be done in such a manner, that the duck may be able to swim a little way into the water. He must then conceal himself within gunshot. The duck will soon begin to "*quack*," and as soon as the young ones

hear her, they will come out to her, thinking it to be their mother.

If he wishes to take them alive, he has only to throw into the water near to the tame duck, a few fish-hooks tied upon pieces of twine, and baited with pieces of the lights of a calf. The lines must be fastened to pickets placed at the edge of the water.

In the beginning of autumn, almost every pool is frequented by teams of wild ducks, which remain there during the day, concealed in the rushes. If these pools are of small extent, two shooters, by going one on each side, making noises, and throwing stones into the rushes, will make them fly up; and they will in this way frequently get shots, especially if the pool is not broad, and contracts at one end. But the surest and most successful way, is to launch a small boat or *traw* on the pool, and to traverse the rushes, by the openings which are found; at the same time making as little noise as possible. In this manner the ducks will suffer the sportsmen to come sufficiently near
them

them to shoot flying ; and it often happens, that the ducks, after having flown up, only make a circuit, return in a little time, and again alight upon the pool. Then the sportsmen endeavour a second time to come near them. If several shooters are in company, they should divide, so that two should go in the boat, whilst the others spread themselves about the edge of the pool, in order to shoot the ducks in their flight.

In pools which will not admit a trow, water-spaniels are absolutely necessary for this sport.

Another good way to shoot ducks in winter, and especially in frost, at which time they fly about, and are more in motion than at any other ; is to watch for them in the dusk of the evening, at the margins of little pools, where they come to feed ; they may then either be shot whilst they are on the wing, or at the moment in which they alight on the water. When the frost is very severe, and the pools and rivers are frozen up, they must be watched for, in places

places where there are warm springs, and waters which do not freeze. The sport is then much more certain, because the ducks are confined to those places, in order to procure those aquatic herbs, which are almost the only food that remains for them at this period.

In times of great frosts, there are also small rivers and brooks which do not freeze, and these afford abundant sport. If the shooter follows the course of these waters at any time of the day, but particularly at an early hour of the morning, he will be certain to meet with wild ducks, which are then frequently lying under the banks, and among the roots of trees which grow on the edges, searching for cray-fish and insects; and the ducks will not get up until he is close upon them, and sometimes they will even lye until he has gone past.

IN

IN the ornithological descriptions which we have given at the latter part of our work, we do not pretend either to the accuracy or the extent of the naturalist. We have contented ourselves with presenting such a concise account as might be useful to the sportsman, from being immediately connected with his amusement.

Those who wish to extend their researches farther into natural history, will find ample information in the work of the immortal *Buffon*: and those who can be content with a smaller portion of knowledge on the subject, may find it in the less sublime and less scientific works of Dr. Goldsmith and of Mr. Pennant.

But as the language of sportsmen possesses a number of specific names peculiar to itself, when speaking of the various objects of their pursuit; it may not be improper to notice them in this place, and we give the terms as they are in our knowledge and acquaintance, and as we have been informed are proper.

Covey of partridge.

Nide of pheasants (commonly called *a ni*).

Pack of grouse.

Wisp or whisp of snipes.

Wing of plover.

Flock of geese.

Bevy of quails.

Flight of woodcocks.

Trip of dottrell.

Team of ducks.

Flock of bustards.



ADDENDA.

A D D E N D A.

SINCE the present work went to press, we have procured specimens of the patent milled shot, as lately altered by the manufacturer, a circumstance of caprice that we formerly noticed : to remedy this ridiculous inconvenience, we therefore here subjoin a table exhibiting the number of pellets composing an ounce weight in each particular size, in the same manner as before.

No.	B. B.	1 ounce	- - -	60
	B.	id.	- - -	67
	1.	id.	- - -	86
	2.	id.	- - -	109
	3.	id.	- - -	160
	4.	id.	- - -	200
	5.	id.	- - -	256
	6.	id.	- - -	444*
	7.	id.	- - -	530
	8.	id.	- - -	600

* There appears to be a great interval between the numbers 5 and 6.

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This paper is to be a great
benefit to the public

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